CEP

CHEMICAL ENGINEERING PROGRESS

JULY 1958

SAFETY

in air and ammonia plants

...the Baltimore Conference Report
page 35

JUBILEE REPORT — Special section carries news pictures, brief review of ceremonials. Humility with discovery, a new cultural era, focus on ability, freedom as stimulus — Speakers' themes covered in brief

PLUS . . . Understanding W. Germany . . . Filter automation . . . HS students' opinions of engineers . . . Programs: Salt Lake City & Heat Transfer meetings .

CEP

CHEMICAL ENGINEERING PROGRESS

July 1958 — Volume 54, No. 7

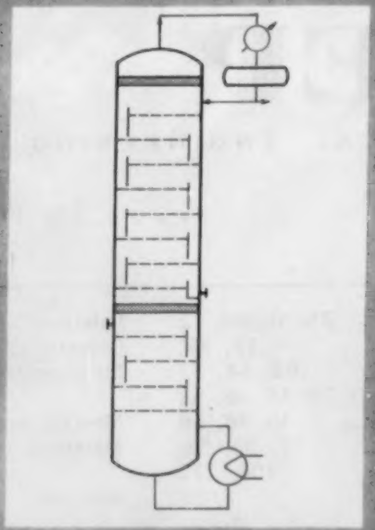
.... in this issue

(Continued on page 5)

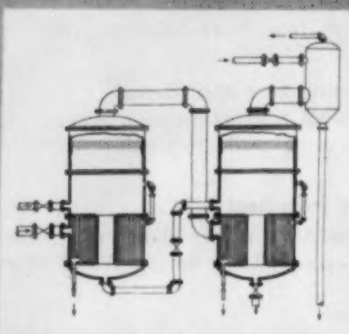
YORKMESH® DEMISTERS

will improve

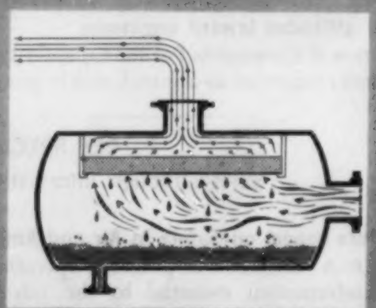
PROCESS VESSEL PERFORMANCE



The efficiency of separation and thruput capacity of distillation equipment can be significantly improved by the use of YORKMESH DEMISTERS.



YORKMESH DEMISTERS installed in evaporators avoid product loss and provide clean condensate.



YORKMESH DEMISTERS installed in Knock-Out Drums result in high separation efficiency at low pressure drop.

It will pay you to investigate YORKMESH DEMISTERS if your process vessels need a lift in efficiency. The versatile knitted wire-mesh pads are being used more and more throughout industry to *stop* liquid entrainment and improve the performance of:

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Here is what happens when YORKMESH DEMISTERS are installed:

1. As vapor disengages from liquid it carries with it fine liquid droplets.
2. When the vapor stream passes thru the fine wire mesh, the liquid droplets impinge on the wire surfaces, coalesce in to large drops, and fall.
3. The vapor is now dry and free from entrained liquid.

Send us details on your type of process vessel or operation, vapor flow rate, pressure, temperature, and density or molecular weight; approximate amount of entrained liquid, viscosity, and specific gravity . . . for existing equipment advise dimensions, indicate vertical or horizontal vessel and material of construction required for mesh and grids. Complete details will make it possible for us to present our recommendations and quotation.

YORK

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Published monthly by American Institute of Chemical Engineers. Editorial and Advertising Offices, 25 West 45th Street, New York 36, N. Y. Communications should be sent to the Editor. Statements and opinions in *Chemical Engineering Progress* are those of the contributors, and the American Institute of Chemical Engineers assumes no responsibility for them. Subscriptions: U. S. and possessions, one year $6.00; two years $10.00 (Applies to U. S. and possessions only). Canada, $6.50; Pan American Union, $7.50; Other Foreign $8.00. Single copies of *Chemical Engineering Progress* older than one year cost $1.00 a copy; others are 75 cents. Second class mailing privileges authorized at New York, New York. Member of Audit Bureau of Circulations. *Chemical Engineering Progress* is indexed regularly by Engineering Index, Inc.

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(Continued from page 3)

departmental features

Case History

How Caterpillar Gets Rid of Refuse... FAST!

At the Morton, Ill. Plant of the Caterpillar Tractor Co. huge quantities of trash and rubbish are generated at many indoor points every day. Containers are placed at these points, and as each is filled, a fork lift truck brings up an empty and carries the full one to the outside pick-up line. Here, the DEMPSTER-DUMPMASTER takes over. Moving down the line, the driver automatically dumps the contents of each container into the 24 cu. yd. packer body, where the material is compressed to a fraction of its former volume. This assures big pay-loads on every trip to the disposal area. Trash and rubbish are enclosed at all times... can't blow or scatter... fire hazard is reduced to a minimum.

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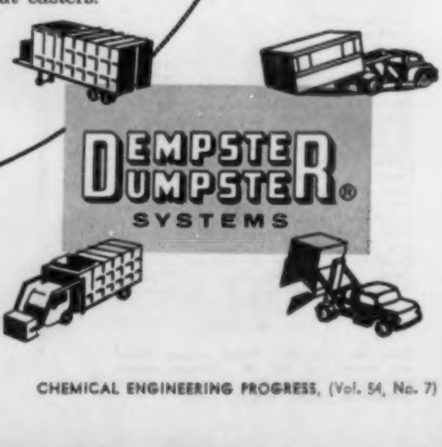

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noted and quoted

New Soviet offensive —Trade and aid

The launching of an earth satellite by the Soviet Union in October, 1957 brought the American people abruptly to a realization of the advanced technical and scientific capacities which now stand behind the threatening posture of the Soviet Union toward the free world.

Earlier in 1953, following the death of Premier Stalin, the new leadership of the Kremlin had launched a different and unannounced offensive against the free nations—a massive program of trade, aid, and technical assistance aimed at the world's less developed countries. The nature of the major aid agreements which the Sino-Soviet bloc has concluded with these "target" countries and the intensity with which the bloc has pursued its trade-aid campaign in the last 3 years have helped to underscore the statement of Nikita Khrushchev, now premier of the U.S.S.R., who declared in 1955: "We value trade least for economic reasons and most for political purposes."

It is of great importance that the American people, now well aware of the technical and scientific challenge posed by the Communist world, understand and rise to meet the equally great, and perhaps more subtly dangerous, offensive which the Sino-Soviet bloc has vigorously launched in the less developed areas. This offensive represents an attempt by the Sino-Soviet bloc to employ its growing economic and industrial capacities as a means for bringing the newly developing free nations within the Communist orbit.

Douglas Dillon, Deputy Under Secretary of State for Economic Affairs, in a foreword to the recently published State Department report on "The Sino-Soviet Economic Offensive in the Less Developed Countries." (Department of State Publication 6632, May, 1958).

Effective communications

"For engineers to serve mankind and be responsible leaders they must enlist greater public participation in engineering progress by interpreting

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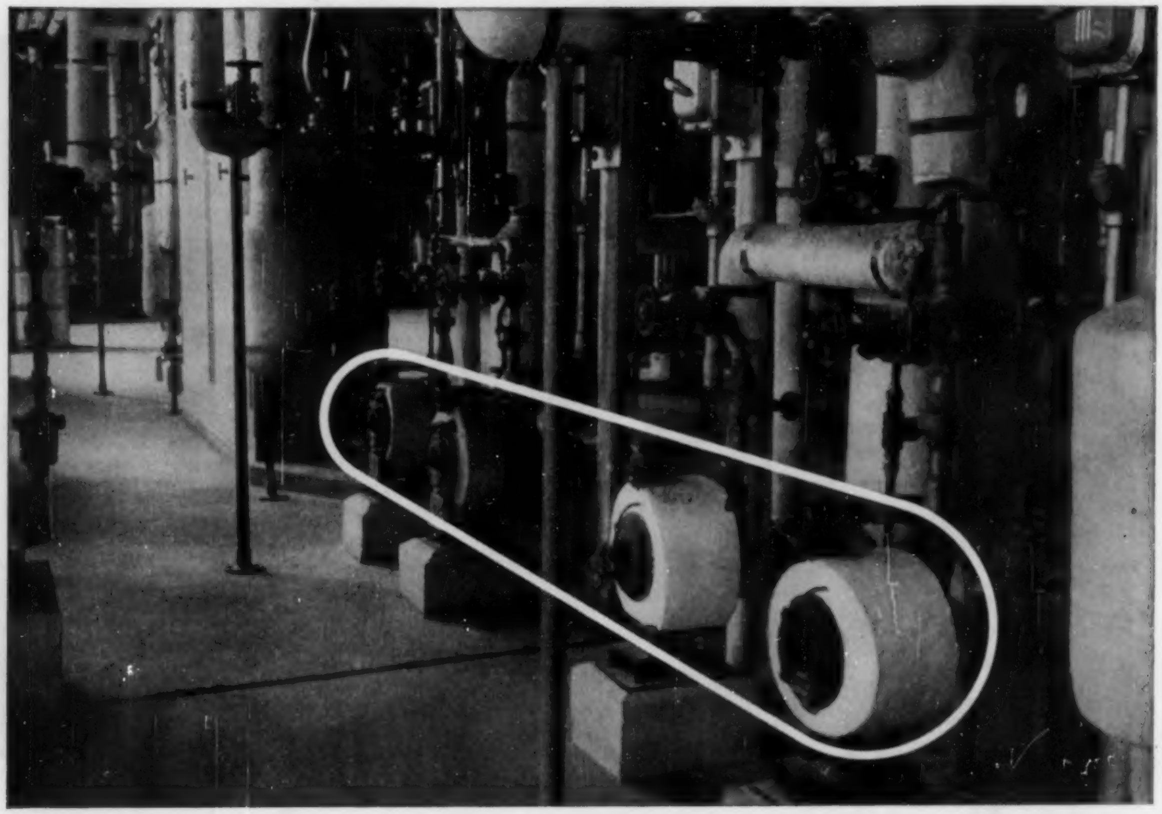

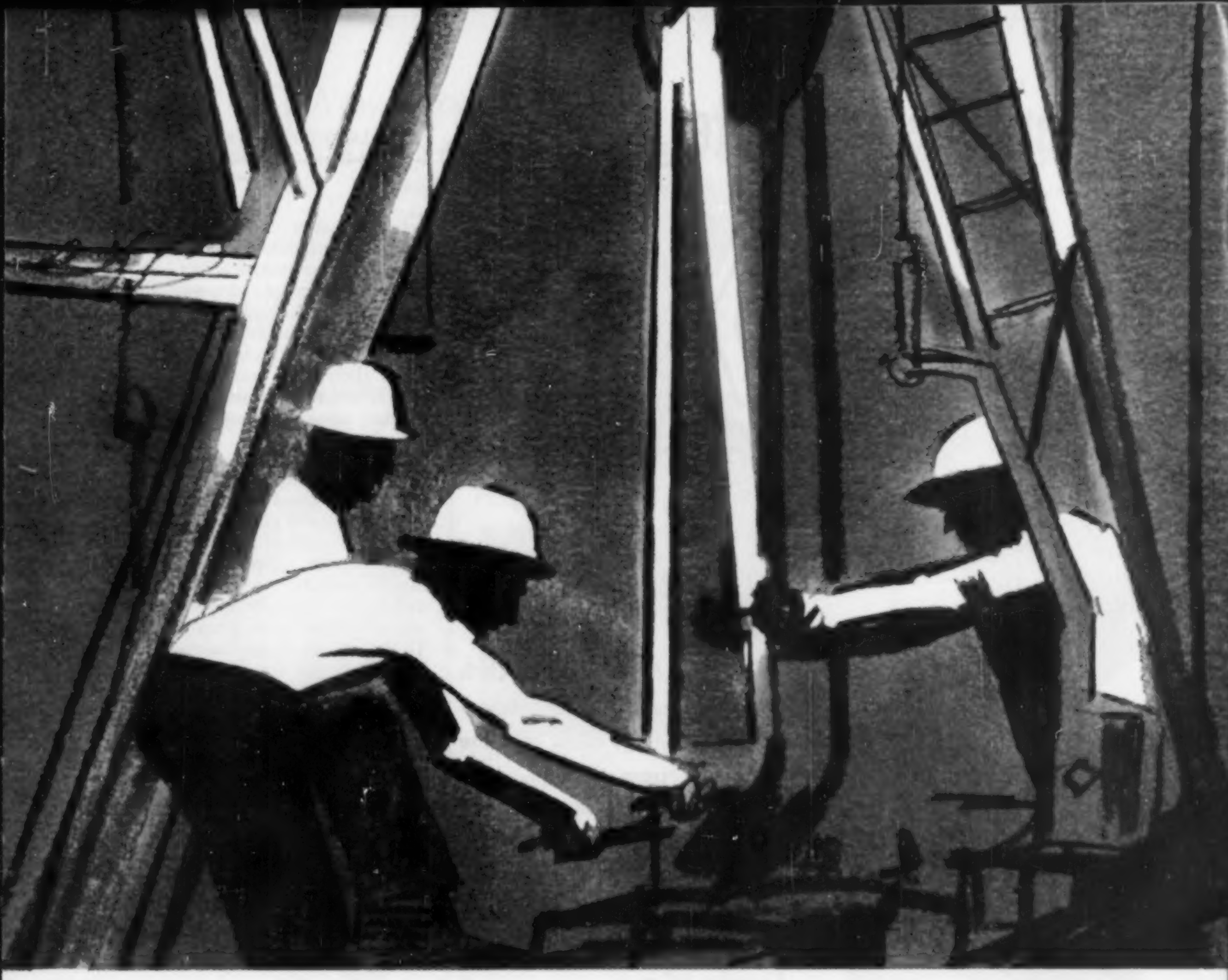

noted and quoted

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technical matters more clearly to the nontechnical public.

"Effective communications — saying the right thing the right way—among engineers, as well as between engineers and the public, demands serious attention. Technology's world grows daily, and transmitting information accurately from one engineer to the other becomes increasingly critical.

"Engineers, it appears, do not always use a common language in their work. One word may have a different meaning to each of three or four engineers who use it regularly. Each feels that his definition is the accurate one, and this feeling inevitably affects the accuracy of what he hears and reads. To be effective, the engineer must know that his words mean what he wants them to, and that they mean exactly the same thing to his audience; he must use language as effectively as the other tools he works with daily.

"The most fruitful area for improvement in this field can be outside the engineer's profession where he must communicate his thoughts to nontechnical people. Technology may well lose much of its deserved support and stature unless it does a better job of telling its story to the world.

"Truly, engineers are faced today with unusually critical challenges and opportunities. There is widespread public interest in science and engineering, an increased appreciation of its importance, but an unguided and perhaps too hopeful dependence on its magic powers. There are many voices calling for crash programs on a crisis basis. Few professional military people, and fewer professional politicians, are particularly qualified to speak with authority on how best to go about the effective application of science. The government and the American people need much more of the sound advice of engineers and scientists of private industry who know well the problems of putting ideas and discoveries into successful and economic production on a vast scale."

From a speech titled "Opportunities for Engineers" given by R. P. Genereaux, Du Pont, at a joint meeting of nine societies, Nashville, Tennessee.


If you need TIGHT connections
you need
EVER-TITE
QUICK COUPLINGS
for safe transfer of your products
Here's proof EVER-TITE excels in
speed... safety... economy
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Extra heavy reinforcing rim
Larger diameter cam ears for longer service life
Extra Hi-Strength forged handles —greater economy
Stainless Steel pins —greater safety and longer service
Uniform heavy wall thickness —no weak spots
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You can speed work—prevent leakage—save wear on equipment by using an EVER-TITE in every operation that calls for couplings. Ever-Tite always gives you tight, quick connections because Ever-Tite has positive gasket compression that is dependable under all conditions. Get Ever-Tites—get a quick, safe, tight couple every time. Ever-Tites are available in:
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Plastics Producers to Push for Bigger Construction Market

Stress Importance of Communications Between Chemical and Building Industries

Greatly increased liaison between basic resin producers, plastic products manufacturers, and the building industry can be credited with tremendously increased use of plastic materials in construction. This includes foamed plastics, surface coatings, adhesives, as well as structural materials. Such was the consensus at the recent Spring meeting of the Chemical Development Association in Niagara Falls, N. Y.

MCA has recently announced its entry into the picture as an interim fact-finding, information coordinating agency on behalf of that part of its chemical industry membership engaged in production of basic plastic materials.

"The $40 billion per year U.S. construction industry at present consumes about $150 million worth of plastics and resin materials annually," said William Demarest of the MCA, speaking before a CCDA session. "The rate of increase in the use of these synthetics in building has averaged some 15% yearly. We can reasonably aim for consumption by the construction industry by the mid-1960's of two billion dollars worth of materials using or made of plastic. To maintain the annual increase necessary to achieve this goal, our industry will have to press actively the development of synthetics for construction. Success in this effort will be possible only if communications with the building industry are developed to a high degree."

Down on the farm

Rural rather than urban areas are proving to be the great testing ground for newly-developed plastic building materials said W. C. Goggin, of Dow Chemical, speaking on Plastic Foams—Markets and Future Trends. Reason—lack of rigid and strictly enforced building codes such as prevail in most highly-populated areas and, in particular, in the great cities. Extensive long-term testing must in most cases precede changes in building codes. This point of view on the suitability of plastics coincided with that of representatives of the American Institute of Architects who stressed that *permanance* is today's watchword in the selection of any type of building materials.

Completely preformed bathrooms that can be lifted by a crane into a roofless house, hooked up to a water supply furnished by rigid and flexible plastic piping is a dream perhaps not too far from reality according to D. W. Maher of Minnesota Mining and Manufacturing, who discussed New Directions for Adhesives in Construction. Such a unit, said Maher, could be adhered and sealed into place. He went on to point out that adhesives already exist which can create a bond capable of withstanding about 10,000 lb./sq. in. In other words, one square inch of this adhesive will easily support the weight of a fully-loaded Cadillac Sedan.

A 1957 report by the editors of "Architectural Forum" estimates that "collectively, our construction expenditures of the next 20 years are expected to add up in dollars to a cool trillion." It is evident that the plastics manufacturers have every intention of getting their slice of the pie.

Major Ammonium Perchlorate Plant for Mississippi

Ammonium perchlorate, an oxidizer used in solid propellants for rockets and missiles, will be made in a new facility in Columbus, Miss., by a process developed jointly by Foote Mineral and Hooker Chemical, parent companies of HEF, Inc. which will operate the plant.

Green Light for Petrochemicals in Iran

A 9 million lb./year polyvinyl chloride plant is slated for early 1961 completion in Ahwaz, Iran, 72 miles north of Abadan. Raw material will be natural gas from the Agha Jari oil field. The project is under the supervision of Development and Resources Corp., N.Y., bid specifications will be prepared by Montecatini of Milan, Italy, who will also oversee construction of the plant by the successful bidders.

Acrolein Plant to Up Glycerine Output at Shell Chemical

Part of a $10 million program by Shell to complete their glycerine production schedule at their Norco, La., plant, a new acrolein unit to be designed and built by Lummus will go into operation late in 1959. The Norco plant will turn out about 35 million pounds of glycerine per year plus substantial quantities of acrolein.

SCOPE

World Engineering Societies Tighten Common Bonds

Better coordination of world engineering literature, and training of student engineers, is the goal of programs sponsored by EUSEC (Engineering Societies of Western Europe and the U.S.) and discussed at the recent meeting in New York. World headquarters for next 3 years will be the U.S., following 3 years in Denmark.

EUSEC was founded in 1948, now comprises twenty-three engineering societies from fourteen countries. Admitted to membership at the recent New York gathering were two new societies: the Ordem dos Engenhiros do Portugal and the Instituto de Ingenieros Civiles de Espana. The new EUSEC general secretary will be W. M. Wisely, executive secretary of ASCE, and the new editor of the EUSEC Bulletin will be O. B. Shier, secretary of ASME. American participating societies are ASCE, AIME, ASME, AIEE, A.I.Ch.E., UET, EJC, and ECPD.

High on the list of subjects under continuous study by EUSEC "working parties" is the matter of coordinating the abstracting and classifying of engineering literature; this is an effort which has recently taken on greatly increased importance in view of the intensive Russian program in this area. In this connection, a possible way around the language difficulty was suggested by A. Ferrari-Toniolo of the Italian Association of Engineers and Architects. His plan—a universal method of coding by the use of electronic translating equipment now in the development stage.

Concentrated attention is also being focused by EUSEC sub-committees on methods of engineering education and training in the various member countries, on facilitating the exchange of lecturers, on extending professional courtesies to society members of one country visiting the country of another society, and on reporting on the fluctuating supply of and demand for engineers so that they may be utilized to their fullest capacity.

President of Major Engineering Construction Firm Sees Strong Future

"The outlook for the balance of the year is favorable. It is possible that new orders for the full 12 months will exceed last year. Our backlog is at a near-record level. The long-range picture remains good." So said recently J. S. Fluor, president of Fluor Corp. Fluor has figures to back up the optimistic point of view. New orders received by the firm totaled $67.5 million, compared with $71 million for the like period of 1957. The firm's backlog of uncompleted work at the close of the first six months of 1958 was $145 million as against $100 million one year earlier.

From Here and There

Anti-recession note—Union Carbide has decided to proceed with construction on their proposed Technical Service Laboratory near Tarrytown, N. Y. Plans were deferred in February pending further study. . . . A new polyvinyl acetate resin plant has been completed in San Francisco by H. B. Fuller Co. . . . Consolidated Chemical Industries, a division of Stauffer Chemical, has just brought on stream a new anhydrous hydrogen chloride plant at Fort Worth, Texas. . . . The President's Committee on Scientists and Engineers will, if present plans are followed, retire from the Washington scene on December 31st of this year. . . . Dateline New York—Engineering union leaders met recently in New York, reportedly analyzed recent setbacks, discussed new approaches to the problem of organizing the country's engineers. . . . Space Agency bills have been reported out by both the House and Senate Space Committees. While the bills differ on degree of military control, etc., it is felt in Washington that some sort of bill will pass during this session. . . . If any Federal scholarship goes through this session, chances are that it will contain many of the provisions of H.R. 12630, recently introduced by Representative Elliott. Sample provisions are: 25,000 undergraduate scholarships; a Federal Loan Fund to be operated through the States; provision for foreign language institutes.

EURATOM reactors

The President has transmitted to Congress for urgent approval a proposed international agreement between the United States and the European Atomic Energy Community (EURATOM). The program involves construction by 1963 in the six EURATOM countries—Belgium, France, West Germany, Italy, Luxembourg, and The Netherlands—of about six large-scale nuclear power plants based on U.S. type reactors. Total capital cost of the reactors is estimated at about $350 million, of which up to $135 million would be furnished by the Export-Import Bank in the form of long-term credits; the remainder would be supplied by the participating European utility companies and other European sources of credit. For the whole program, EURATOM would act as a coordinating agency, for technical matters as well as for arranging financing, etc. It is probable that certain key processing equipment would come from the United States, with the rest being furnished by European suppliers. The program also includes proposals for joint research and development, and for U.S. reprocessing of spent fuels until suitable facilities can be erected in Europe. Prospects for a passage of the agreement during this session of Congress are considered fair to good.

J. L. Gillman, Jr.

SCOPE

Employment of Engineering Graduates Looks Better

Contrary to recent pessimistic opinion, 1958 engineering graduates should not have too much trouble finding a job in their chosen professions. This is the conclusion of a survey carried out recently by the Engineering Manpower Commission of the Engineers Joint Council. Reports are on hand from schools which are awarding 14,511 bachelors degrees in engineering.

The figures show that, as of about June 1st, 8,558 students had jobs lined up, 1,690 were still considering job offers, 1,495 were planning graduate school work, and only 1,570 (10% of the class) were still without job offers. It is interesting to note that, by contrast, the same schools reported 2,505 business administration graduates, of which 25% were still without job offers. Liberal Arts graduates fared even less well with about 30% still uncommitted.

Among the strictly engineering disciplines, chemical engineers were slightly below the general engineering average, with some 16% not signed up. At the top of the list are the civil engineers with only 6% without jobs. However, this low percentage may in part be attributed to the demands of the Federal Highway Program which is now going into high gear.

Trends in the United States Department of Labor clearance lists are also on the encouraging side. These lists, which record demands for engineering personnel that cannot be met from local sources, show a rise of about 60% from a low in the closing months of 1957 to a high in March of 1958. Since March, the demand has been relatively steady at the higher level.

Washington Notes

Capitol sources are optimistic on the recession picture. The Pentagon reports an increase in defense orders in May and predicts an even greater increase in June. Steel operations have jumped from 50 to 65% of total capacity in the past 60 days. Contract awards for highway construction are being made at a record rate with almost a $5 billion total planned for 1958. Some government economic experts believe that Federal purchases of goods and services in the fourth quarter will exceed 2nd quarter totals by more than $3 billion—a decided "kick" for the economy. . . . Information on what to do in the case of an incident involving radiation in any local area may now be obtained from your nearest AEC office or military installation. Detailed instructions are currently being distributed to these agencies by the AEC and the Defense Dept. . . . Washington rumors have it that considerable work is being quietly done in an effort to copolymerize ethylene and propylene. Hoped-for goals are higher strength and better heat resistance. . . . Changes in the high command of the AEC were highlighted by resignation of the following: Chairman Lewis L. Strauss, who is succeeded by John A. McCone, president of Joshua Hendy Corp., Los Angeles, and former Under Secretary of the Air Force; K. E. Fields, General Manager, who is followed in office by Air Force Major General Luedecke; and R. W. Cook, Deputy General Manager, who leaves to join American Machine & Foundry. In the Reactor Development section, W. Kenneth Davis, Director, will be vice-president of Bechtel Corp., San Francisco, and Louis H. Roddis, Deputy Director, is to be president of Pennsylvania Electric Co.

J. L. Gillman, Jr.

Corn Surplus is Research Target

Research can reduce the corn surplus, the Senate Agricultural Committee has been told by J. W. Evans, chairman of an industry research group. Specific projects include use of starch in paper manufacture, in metallurgy, and in insecticide and defoliating formulations. "These three projects would cost an estimated $6.5 million and could lead to an annual consumption of some 410 million bushels of corn," said Evans.

Urea takes to the woods

Aimed at a thermosetting-plastics wiring device and closure market estimated at 64 million pounds per year, the only wood-filled urea plastic plant in the country will be put on stream this month by Allied Chemical at Edgewater, N.J.

Roughly equivalent to phenolic in price, the new wood-filled urea molding compound is said to surpass it in colorfastness and arc resistance. The 1957 market for phenolic molding powder was about 34 million pounds; the product went into surface-base wiring devices, wall plates, light sockets, circuit breakers, and circuit boxes. Improved electrical characteristics of the wood-filled variety should insure its getting a large share of this market, says Allied. In the packaging field, the new product will compete with about 30 million pounds of thermosetting molding compounds annually channeled to this use, of which 12½ million pounds is alpha cellulose-filled urea.

Salaries for Engineers

Based on the 8-grade NSPE chart of pre-professional and professional positions, the Texas Society of Professional Engineers has come out for guaranteed minimum salaries for engineers ranging from $5,200 to $20,000. Comparable recommended teaching salaries for the same grades range from $4,200 to $18,000 for a nine-month academic year.

marginal notes

ELECTROSTATICS IN THE PETROLEUM INDUSTRY—THE PREVENTION OF EXPLOSION HAZARDS—A. Klinkenberg and J. L. Van der Minne—Elsevier Publishing Company, Amsterdam, London, New York, Princeton, 191 pp (1958), $8.00

Reviewed by M. M. Braidech, Direc-of Research, The National Board of Fire Underwriters, New York, N. Y.

This text is a Royal Dutch-Shell development report and contains a wealth of information on the generation, accumulation, discharge, and control of electrostatic energies caused by flow of hydrocarbons in petroleum refining and handling operations. It is well written and reflects much research and development with considerable achievement towards practical solution of the problem.

The treatise ably describes the underlying principles and intricacies of electrostatic charging, and the production of high voltage by motion of petroleum products during pumping, mixing, filtering and pipeline conveying (with narrowing sections), and turbulence in agitation, gas release, and overhead splash-filling. As far as is known, the formation of strong electrification during settling of swarming small particles and water droplets in petroleum products has not been previously reported in literature.

The text has good theoretical-mathematical treatment of the subject that is comprehensively accessible. The authors point out that while pure hydrocarbons are almost inert electrically and do not exhibit any charging effect, the presence of certain compounds (particularly in treated gasolines), even in trace amounts [as little as 0.001 p.p.m.], will greatly change the electrokinetic charging effect. These impurities may include asphaltenes, metal salts of naphthenic and sulfonic acids and various oxidation products and organic electrolytes. It is pointed out that adequate removal of a charge from any liquid depends upon the balance between the rate of charge built up and the rate of leakage or drain-off by earthing or grounding.

A new and most promising and practical method is reported for overcoming difficulties with static by large-scale use of antistatic additives. These impart strong conductivity to the hydrocarbon liquids. (The use of magnesium soaps for safer dry cleaning is a long-standing example of such

treatment.) It is reported that petroleum products can readily be made safe with minute concentrations of certain metal salts, especially when used in combination with other metal salts. Trivalent metal salts, such as the aluminum salt of diisopropyl salicylic acid were found to be outstanding. The ideal additive was found to consist of two substances which jointly can improve conductivity several thousand times and, at the same time, neutralize each other's charging effects. These include the chromium salt of mono- and di-alkyl salicylic acid and sodium di (2ethylhexyl) sulfo-succinate. Concentrations as low as 0.014 lb. /1000 bbl. have been found effective. Some commercial anti-corrosion additives, notably ethylene diamine di-nonyl napththalene sulfonate, also were found to have moderate antistatic properties. Research in this direction is continuing with various compounds and process equipment.

Treatment with additives does not do away entirely with the necessity for grounding or earthing; however, it is reported that if the two means (chemical and physical provisions) are used, the pumping rates can be greatly increased in refinery operations (especially in pumping gasoline and water through pipe) and tanker loading. One of the greatest benefits is claimed for rapid fueling of military aircraft (where flow velocities as high as 18 m./sec. or over 3500 ft./min. are encountered.

Considerable material is presented on electrical conductivity of technical and purified hydrocarbons, including measurement methods, effects of electrolytes, and results with additives, together with a good discussion of grounding (earthing) and minimum energies required to initiate combustion and explosion. Laboratory observations are supported by large-scale tanks, which simulate plant conditions.

Having been faced with explosion experiences where apparently no safety rule had been broken, the authors have made a painstaking and intensive study in truly getting to the root of the problem.

Russian-English Electronics and Physics Glossary, *Consultants Bureau Inc.*, New York, N.Y. (1957), 343 pp., 10-p. Appendix, $10.00.

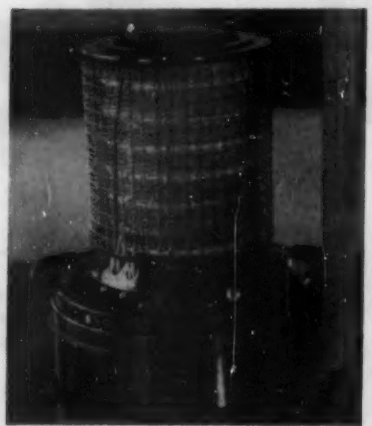
This glossary includes more than 22,000 Russian terms, adds new ones, including idioms and selected general vocabulary.

Thermo-electric generators—in 1946

I was interested in noticing on page 21 of the May issue of CEP the article by Gilman, "Power Directly From Heat in the Near Future."

As far back as 1945 and 1946 the Eaton Manufacturing Company in Cleveland was offering for sale a thermo-electric generator which looks considerably superior to the alleged Russian unit. RCA, Sears-Roebuck, etc. estimated they might sell (at that time) as many as 400,000 thermal units for use as powering rural radios. These units were quite delicate and required, of course, 100% operation of the many hundred (or few thousand) welded connections. I think this was the biggest industrial difficulty, for efficiency in fuel costs really didn't enter in.

Actually, the OSS units operating under General Donovan in Southeast Asia, Burma and India used a number of these units, parachuted into the territory, and actually fueled—according to the story—with yak dung. After the war they were considered for commercial service, but were obsoleted by other technological advancements.



The Eaton thermo-electric generator as pictured in Eaton's 1946 catalog. Above as assembled. Below, showing the oil heater unit detached.

Note the Eaton catalog pictures attached. The Eaton people were even considering using the thermo-electric generator to operate the fan on the oil burner. I do not know if they ever got this far but understand they have not been pushing this program since 1946.

I also do not know what additional information is available which can be published, but judging by Gilman's article, there hasn't been much progress in this line in many years.

LAUCHLIN M. CURRIE

Union Carbide Nuclear
New York

More on Saline Water

Here is some added information which may be of interest in reference to the article entitled "Saline Water Conversion . . . Big Business of the Future?" appearing on page 160 of the April 1958 number of CEP.

We are just getting into operation a plant to distill sea water on the Island of Aruba in the Netherlands West Indies. The first unit is expected to be in operation in June and all five units by the end of the year.

The plant was designed and is being built by Singmaster & Breyer for the Government of Aruba. It will be the sole fresh water supply for the 55,000 people who live on Aruba. It includes the necessary spares to assure a constant, reliable water supply. Further particulars are as follows:

Cost—$11,000,000.00.
Capacity—2,700,000 gals. per day.
Plus about—11,000 KW electric power.
Fresh Water—5PPM total solids.
From Salt Water Feed—36,000 PPM total solids.
Evaporators from G. & J. Weir, Glasgow, 5 units—6 effects each.
Weir nonscaling process permits maximum boiling temperature—212°F. plus.
Boilers—B&W—2 (1 spare) 200,000 lbs. per hour, oil fired.
850 psig—815°F.
Turbo-generators—Oerlikon—15,000 KW.

Operating costs will not be known until the plant has been in operation for a year or so. They are expected to cut the present cost of water at Aruba ($3.50/1,000 gal.) about in half with some possible further reduction due to credits for power.

Aside from the fact that the CEP article made no mention of what we believed to be the biggest fresh water from sea water plant in the world, the article was very interesting and well presented.

JOHN P. HUBBELL

Singmaster & Breyer
New York

Trade secrets

Late in April a U. S. District Court in Utah rendered a decision in favor of the Monsanto Chemical Company against a former employee, Mr. Charles M. Miller. This decision upheld the Monsanto employee contract which seemingly forever prohibits the disclosure or use of trade secrets or confidential know-how.

Forever is an exceedingly long time and progress in engineering is so fast that no engineer should be prohibited from practicing in the field with which he is most familiar.

Under modern engineering conditions and with modern scientific know-how, except in the narrow nuclear field and in such fields as perfumery, trade secrets should be as dead as the dodo bird. Trade secrets and confidential know-how, to have practical economic value, must be based on our universal scientific knowledge. From this universal fund, who can judge what knowledge the engineer brings to his job and what he acquires at his work.

Our patent courts are not friendly to monopoly nor do they favor protection for eternity. Courts outside the patent field should be suspicious of trade secrets which do not seek the protection of patents.

Undoubtedly, where actually existing, a trade secret has property value, but I believe that the owner could be protected by charges of theft or misappropriation of records rather than through the breach of an employment contract. Detailed specifications, operational directions and blue prints should be subject to full protection as property and the legal action should be against the responsible individual. The delinquent individual, and not the entire profession, should be penalized.

H. LESLIE BULLOCK

New York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ENGINEERS are saying this about Peerless Process Pumps—
WE CAN BE SURE!
PEERLESS PROCESS PUMPS offer pinpoint selection. Thousands of combinations from the complete Peerless line assure you of characteristics that fit exactly your system's every requirement.
PEERLESS PROCESS PUMPS meet today's pumping needs, and tomorrow's as well. Peerless process pumps are built to expand with your future system and still offer a custom performance pump at an off-the-shelf price!
PEERLESS PROCESS PUMPS provide field-proved performance, verified by thousands of case histories of pumps in all duties. With Peerless, you get a pump that you know will do exactly what you buy it for.
RESEARCH AT PEERLESS is exemplified by this bulletin, "MECHANICAL CONSIDERATIONS IN PUMP DESIGN," dealing with the effects of radial loads on process pumps. Request Bulletin No. EM-79.
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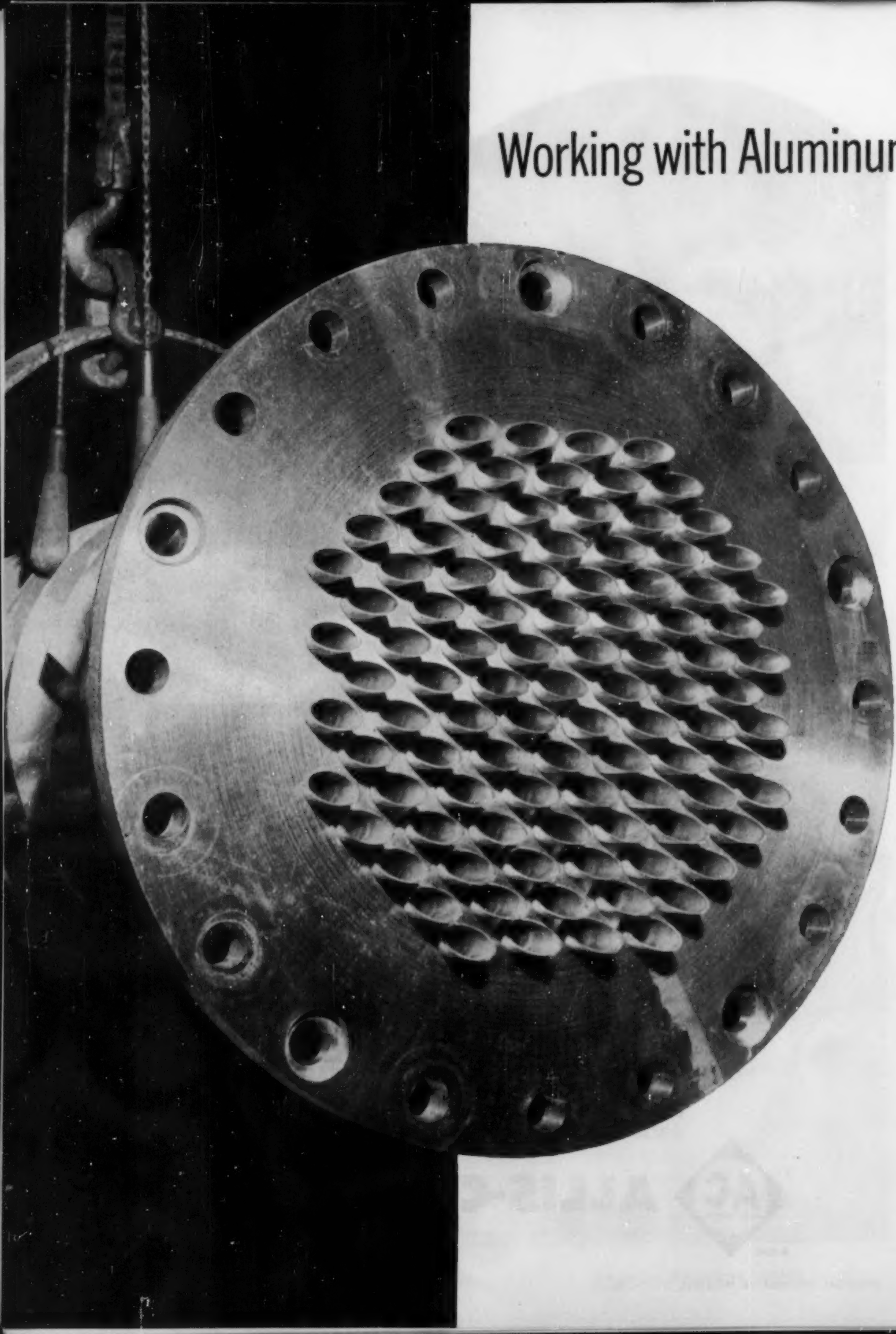
Working with Aluminum



is a Talent at...

Vulcan manufacturing

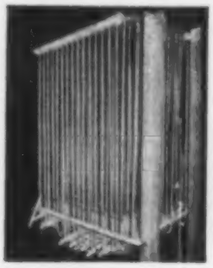
In the application illustrated at the left, Vulcan Manufacturing successfully designed and built this large heat exchanger of type 3003 aluminum.

We do not consider this unusual.

It does, however, indicate to you a talent for working with the various metals and special alloys that are more and more becoming a part of today's process equipment. This heat exchanger is typical of the wide variety of custom designed process components engineered and fabricated at Vulcan and now in successful operation. This also includes fractionating towers, extractors, evaporators, and special pressure vessels. And it encompasses wide experience with many materials including copper, stainless steel, carbon steel, aluminum, nickel, Everdur, Monel, Inconel, Hastelloy, Carpenter 20, Karbate — even plastics.

We'd like the opportunity to put this experience to work for you. For more information, call or write:

Copper ...
and Everdur were combined in the fabrication of this condensing section



Stainless ...
type 316 was used for this ultrahigh vacuum fin tube condenser

Monel too!
Used here on a bubble cap tray for a chemical reaction tower

Vulcan manufacturing

120 Sycamore Street, Cincinnati 2, Ohio, Dunbar 1-1400

Designers and builders of process equipment

VUL-603

about our authors

Eminently qualified as a CEP author is **William G. Strunk** of FMC Organic Chemicals Division (Preparation and Properties of Unsymmetrical Dimethylhydrazine). Behind this paper lies Strunk's from-the-ground-up experience in the development of the hydrazine process—from an economic as well as a technical point of view. After graduation from the University of South Dakota, Strunk (a native South Dakotan) started work in the research and development organization of Westvaco Chlorine Products Corp., later to become the Westvaco Chlor-Alkali Division of Food Machinery and Chemical. His present position is in the development department of FMC's Chemicals and Plastics Division.

Well-known to CEP readers, **Donald F. Othmer** started his professional career over thirty years ago in the development of processes and plants for recovery of acetic acid from wood distillation liquors and cellulose acetate. At Brooklyn Polytechnic Institute (where he is now professor and head of the Department of Chemical Engineering), Othmer did the process engineering for numerous acetic acid plants in this country, Europe, South and Central America, and Asia. Recently, he was selected to present a general lecture at the European Congress for Chemical Engineering held in conjunction with ACHEMA, the triannual exposition of chemical equipment in Frankfort am Main, West Germany. His topic was acetic acid recovery; the article in this issue of CEP has been adapted from this presentation. Othmer is a director of A.I.Ch.E. and a former chairman of the New York Section.

Authors Othmer, Strunk and Landau in this issue.

James F. Zievers, who with **Clay W. Riley**, authored this month's paper on Automation of Filtration Equipment, has been involved in a program of studies on automation of filtration, waste treatment and ion-exchange equipment at Industrial Filter & Pump Mfg. Co. Material in the paper, according to Zievers, is based on actual test results. For example, the

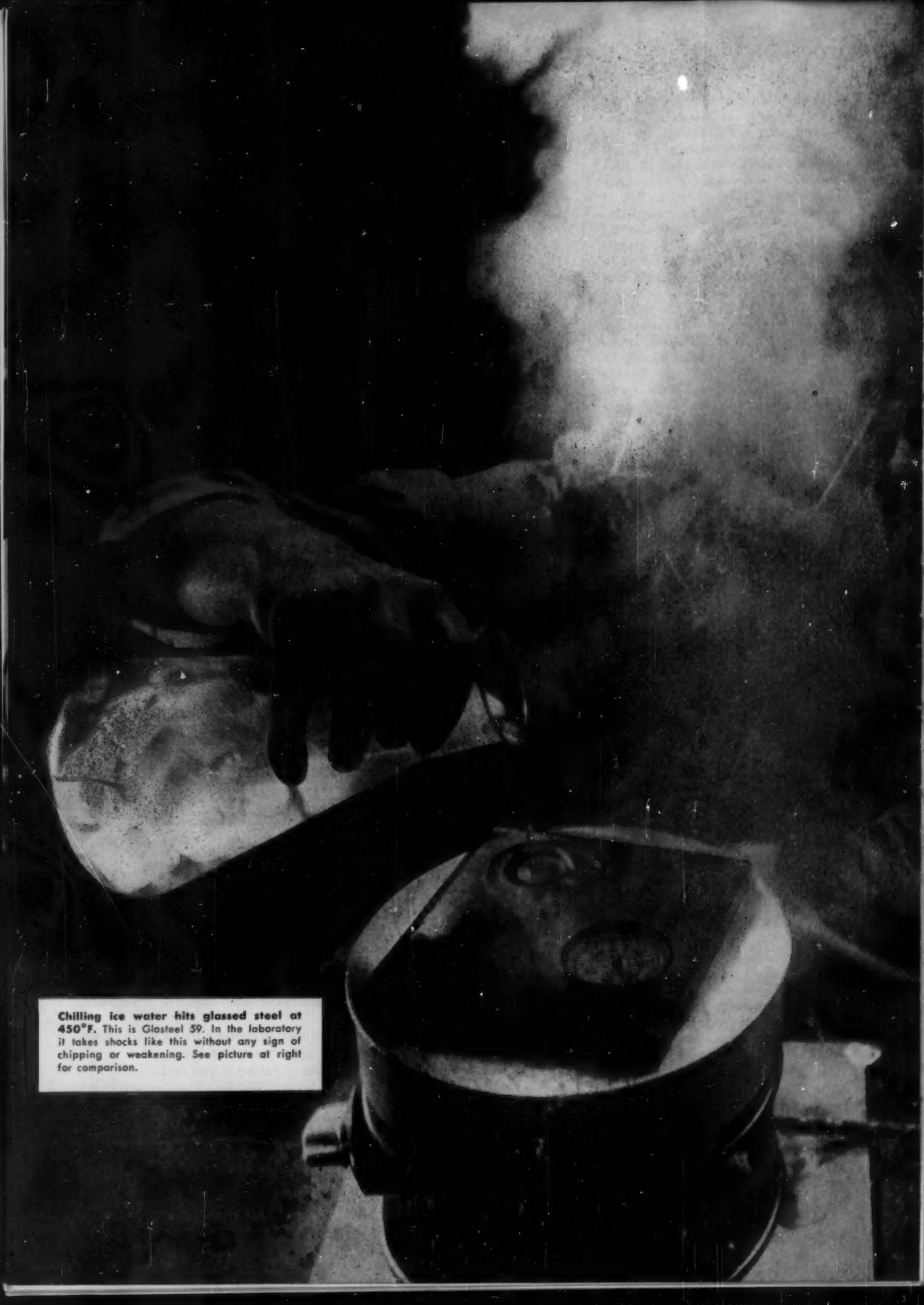
continued on page 27

particular sequence described in the article has been in continuous operation for two years. Reason for this long-term test operation is to determine and record breakdown data for the various components of the system. An interesting outcome of this field of study has been the recent completion of a fully-automatic filter station for a sugar refinery project in the Middle East. The station is slated to go on stream about February, 1959. Current investigations at Industrial Filter & Pump, says Zievers, are now tending toward the examination of in-line apparatus rather than the use of retention tanks at various points in a chemical process. Within 18 months, the author believes, there will be forthcoming equipment designs of major significance to the chemical industry, particularly to those segments which are vitally interested in the application of automatic techniques.

Another important contribution to the literature on spray drying techniques is the paper on Spray-Drying and Particle Properties, co-authored by **W. R. Marshall, Jr.**, of the University of Wisconsin and **E. J. Crosby**, who is now affiliated with the Technical University of Denmark in Copenhagen.

Chemical Engineering in West Germany is a must for those whose engineering work involves contact with European scientific thought and practice as well as for those interested in foreign systems of education for chemical engineers. **Ralph Landau**, the author, who is presently executive vice-president of Scientific Design Co. has drawn on an extensive background in the import and export of processes, and on material garnered during a recent prolonged European tour of inspection. Landau holds the degree of Sc.D. in chemical engineering from MIT, and worked for several years as a process and development engineer for M. W. Kellogg. During World War II, he was involved in the famed Manhattan District Project.

Authors, too, but in a different sense are the hard working Committees which have set-up the two major A.I.Ch.E. meetings whose complete technical programs are presented in this issue together with details of what to see, where to go, and how to go about it—Heat Transfer in Chicago, August 18-21, and Salt Lake City National Meeting, September 21-24. **A. S. Foust** is the technical program chairman for the Heat Transfer meeting on behalf of A.I.Ch.E., and **E. B. Christiansen** performs the same office for the Salt Lake City meeting.

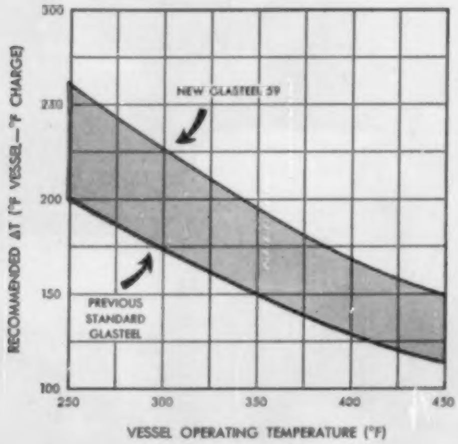


Chilling ice water hits glassed steel at 450°F. This is Glasteel 59. In the laboratory it takes shocks like this without any sign of chipping or weakening. See picture at right for comparison.

THERMAL SHOCKING NEWS

about new Pfaudler Glasteel 59*

If you have ever crazed a glassed-steel vessel from thermal shock . . . if for any reason your processing is less economical than it might be from risk of thermal shock . . . take a close look at the blue line on this graph.



That blue line marks the new high in thermal shock resistance set by Pfaudler Glasteel 59.

Just a quick glance at the graph shows that Glasteel 59 gives you 30% more thermal shock resistance than the best previous glassed steel. It provides added insurance against thermal shock damage where unexpected or unavoidable high-temperature differentials are encountered.

At your normal vessel operating temperature, the safe ΔT for Glasteel 59 is 260° F. It used to be 200° F. At the peak operating temperature of 450° F., safe ΔT is now 150° F. It used to be 115° F. All these figures contain a very generous safety factor of *three*, based on carefully controlled laboratory experiments.

Lasts longer. Glasteel 59 will give you much longer service life from your vessels.

20% more abrasion resistance. Glasteel 59 gives you a full 20% more abrasion resistance than previous glassed steels.

Top acid resistance. Now you can work any acid, except hydrofluoric, up to 325°F. without excessive corrosion.

Under certain conditions you can even raise an acid to 450°F. without damage.

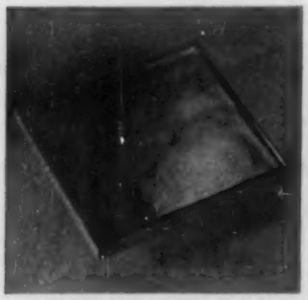
Very good alkali resistance. Glasteel 59 has twice as much resistance to alkalies as your hard glass labware.

Lapped nozzle faces. The unique microstructure of Glasteel 59, which is the reason for improved thermal shock resistance, also allows lapping of nozzle faces on vessels above 500 gallons—smaller vessels on request. You get better gasket seating and more service life.

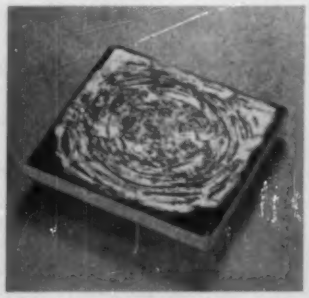
Plug-free vessels. In many of the small and intermediate sizes we offer plug-free vessels with Glasteel 59. On all other vessels there are fewer plugs than before.

No additional cost for Glasteel 59 on all Pfaudler standard equipment.

Send for new Buyer's Guide. The new 1959 Pfaudler Buyer's Guide shows all the glassed-steel equipment available with Glasteel 59. Write for a copy. Just ask for Bulletin 968.



No thermal damage whatsoever was suffered by Glasteel 59, shown at left. All Pfaudler vessels are now available with this new construction.



Chipping and crazing appear all over this plate of the best previous glassed steel subjected to the same shock as the Glasteel 59 plate.

The most complete line of glassed-steel equipment for the process industries is now available from Pfaudler with the new Glasteel 59 construction.

THE PFAUDLER CO.
a division of **PFAUDLER PERMUTIT INC.**
Dept. CEP-78, Rochester 3, N. Y.

*Patent Pending

CEP trends / Upturn?

The year is now moving into summer and the period of plant vacations and summer shutdowns is at hand. Industrial managements now generally feel that the recession has touched bottom. Chemical business was somewhat better in the June quarter, and earnings of many chemical firms were also slightly better than in the low first quarter of the year.

But the big question still is how soon a real recovery will come, and how great the rebound will be. Therefore, while confidence grows about better business in the fourth quarter, the outlook for summer has many chemical managements nervous. In many divisions of the chemical industry sales will fall off, and there is a fear that plant shutdowns may be longer than usual.

There is little hope that a strong recovery will come in the next month or so, deferring tangible evidence of business trends until fall. A few months of doubt and dullness seem ahead. A soft stock market at the end of June reflected this same feeling in financial circles, also fed by the pessimism of those in Wall Street who do not look for any great recovery this year.

Consumer income continues at a remarkably high level, running in May at an annual level of $344 billion, against an April low of $343 billion, and down only a little more than 1% from the August 1957 high of $346 billion. Those who lean to the pessimistic side point out that in a recession consumer spending is the last to decline, but it might be remembered that all recessions differ a little from each other in the factors involved.

Textiles move up

One favorable factor in the outlook is that the long depressed textile business is feeling a little better. One of the big rayon companies reported in June that its main plants were running at capacity for the first time in a number of years.

The automobile business is of course one of the chief keys to the future course of the economy. Upon its activities in the last part of the year will depend the fortunes of the chemical industry in that period. Industry reports indicate that production in the third quarter may be as low as 600,000 to 700,000 cars, about 50% below a year ago and the lowest since 1941. Thus even if sales continue to run at the current low 4,000,000 annual rate, stocks may be down to around 350,000 to 400,000 cars. This would indicate the necessity for a sharp increase in production in the final quarter of 1959 models perhaps up to 1,400,000 or more cars. This should mean the beginning of buying for chemicals, steel and other supplies in September carrying over into the fourth quarter.

Steel operations rebounded from their low level of around 50% of capacity to about 65% of capacity during June. Part of this was probably caused by buying in anticipation of a price advance in July. They are now likely to decline again during the next month or so when motor company operations are at a low ebb but here again forecasters are looking for a sharp pickup in the final months of the year. Some steel men have been quoted by their chemical suppliers as saying that they are hopeful that their operations may bounce back to around 75% of capacity in the final three months of the year. This of course will give a sharp stimulus to business in ferroalloys, in acid and in oxygen.

Price cutting

The chief dark spot in the chemical picture is the weakness in the price structure and the price cutting that has taken place in a number of fields. There has also been a good deal of "under the counter" selling at below list prices. Outstanding examples have been in ammonia, which has long been obviously a candidate for trouble because of notable overproduction, and in sulfuric acid especially on the East Coast. In spite of efforts of some major producers of ammonia to hold the price line, smaller producers having new plants which they naturally wanted to keep running cut prices and upset the whole price structure of the industry. The same thing happened to cause the six cent a pound cut in methanol and sulfuric acid on the east coast. In this case a price cut has not been announced but producers are meeting the $4 a ton price cut made by one firm.

On the Washington front, now that economists there feel the tide is turning, a major cut in income taxes is unlikely particularly since it expected that the budget may be unbalanced for some time.

CEP opinion and comment

HS STUDENTS' ATTITUDES TOWARDS ENGINEERS

IN January, this column reported on attitudes of high school students towards scientists, and expressed concern that the students might continue to have such distorted views.

Now, a further poll of high school students—this time having to do with engineers—has been completed by the Purdue Opinion Research Panel. This was reported on by Mr. Maier of that organization at the Philadelphia Jubilee meeting of the Institute. Mr. Maier summed up the Panel's conclusions rather humorously as follows: "The students think engineers are the bastions of our strength but that the scientist is an incompetent radical."

Three polls have been taken within the past year, and reports are based on responses of 2,000 students carefully selected to be representative of the high school population throughout the country. The first two polls were about scientists and the third about engineers. Methods used were similar.

The engineer, according to 90% of the respondents of the last poll, is "a sound, stable citizen—quite a contrast to their image of the scientist."

When asked the question, "which one of the following occupational groups has contributed the most to our standard of living?" the engineers were selected by one-third of the students; teachers were ranked second with 25 per cent; business managers, political leaders, farmers and religious leaders were all less.

Twenty-nine per cent think engineers are likely to sacrifice the welfare of others, in contrast to the earlier reported 38 per cent relating to scientists in a similar question.

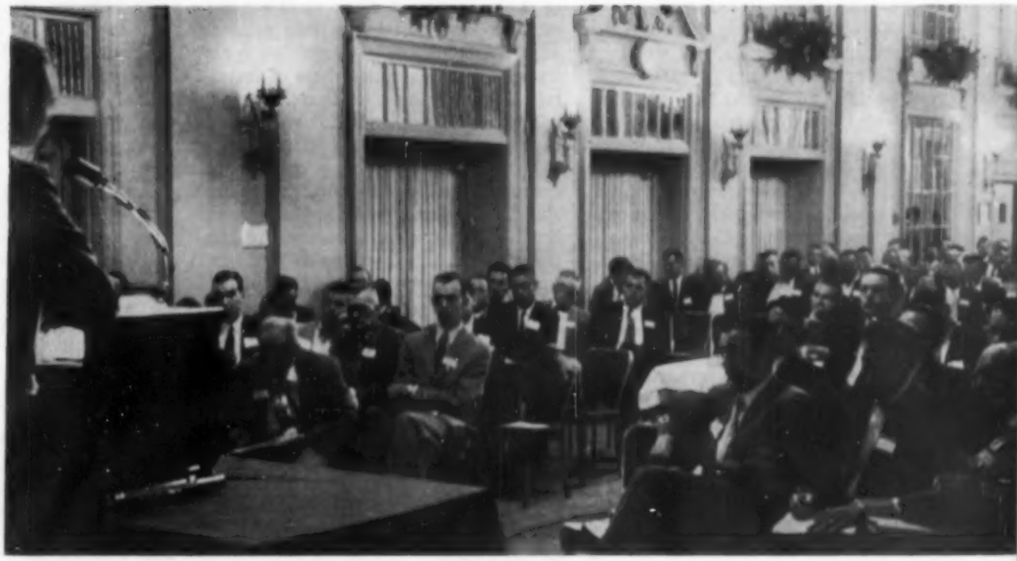
"Probably the most important consideration," continued Mr. Maier's report, "is the desire of young people to enter the profession. We find that a whopping 64 per cent of the boys—even 14 per cent of the girls—would like to be engineers!" Only 7 per cent think of engineering as an easy college major, however, and 82 per cent think a person must have a talent for mathematics to be an engineer.

Of particular interest is the finding that *three-fourths think engineering is comparable to medicine and law as a profession*. Thus, the future generations may solve the problem of professional status, whether educated as engineers or not, through entering into adult life with such attitudes.

"Engineers," concludes Mr. Maier, "do not suffer from the large amount of negative stereotyping associated with scientists."

These are facts which should encourage the engineering profession, encourage particularly those who have worked hard in recent years to bring the positive picture of engineering before the youth of our nation. We should regard as a danger, however, the distinction between engineers (practical people) and scientists (more theoretical people). For one can never be sure that, in his more profound moments, the engineer may not be mistaken for a scientist! This could be ego shattering. But more seriously, it does indicate a distrust of the more fundamentally oriented person, and we should not cease to support appropriate remedial activities until this problem is eradicated.

J.B.M.



A big session gets underway and an alert and anxious group—all eyes and all ears — appears to be taking everything in.

. . . . . . the operators report on

SAFETY

in air and ammonia plants

In a CEP exclusive, chemical engineers in air and ammonia plants analyze and discuss problems of actual case histories of full-scale operating and maintenance experience involved in the safe operation, maintenance and expansion of all air and ammonia plants.

This is Part 1—Ammonia Plant Safety. Parts 2 and 3 — Air Plant Safety — will appear in August CEP.

Chairman H. E. MAUNE (Mississippi River Chemical Co., Crystal City, Mo.): The first item I'd like to start with concerns ammonia plant operation. It has to do with the high pressure systems and I think we should be mainly concerned with metal inspection of vessels, piping, exchangers and miscellaneous equipment. At this time I will call on Mr. King from Sohio Chemical Co. to introduce the subject of metal inspections.

KING, Sohio, Lima, Ohio: Sohio is relatively new in ammonia operation. However, I took this opportunity to introduce the metal inspection portion of this program since a new operator might have something novel to review. Of interest may be the things observed in the two shutdowns we have had, one carried out in October 1956, and one we completed in August 1957.

In the converter section of the high pressure synthesis loop we have not had any evidence of nitriding, a subject which we will cover later on in these sessions. We have taken the opportunity to open a synthesis converter at each inspection and have actually performed some repair work, or revamp work, on the converter basket.

External forces have come into play in the synthesis section and have left their mark. The necessity for a good water treating method is an example. We are using exceptionally hard water in high temperature service. There is some evidence of sulfur in our well water also. As a result we lost the high pressure coolers on the converter effluent through external corrosion. In our particular process the converter effluent flows through a fin-fan cooler, utilizing air coolers, as the first step, well water coolers for the second.

The major cause of failures in the high pressure section has been vibration. We have gone into great detail to unitize all appendages to our high

pressure piping and vessels. The one fire that we have experienced in the synthesis section resulted from the cracking of a nipple at the pressure gauge connection. In our process we have an externally fired heater in the synthesis loop. The failure occurred on the pressure tap at the inlet to that heater. Since that time we have surveyed the entire high pressure section for points where compressor vibration can contribute to that type of failure. We have unitized all of these small appendages through gusseting and framing, making them a part of the piping or the vessel.

To move back through the rest of our system we have in gas purification an MEA system for CO_2 removal and a copper solution process for CO removal from the synthesis gas. There we are faced with the problem of MEA corrosion in the high temperature portion of the CO_2 stripping equipment. We have gone to the use of Monel at the highest temperature points. At medium temperatures, all have exchangers of 316 stainless steel or 4-6% chrome. Carbon steel is used in the cooler portions of that system. In the CO removal system, we have found that the simplest type of installation is the best for handling the copper solution. Any dead spaces are to be avoided. Remove or weld over anything and everything that might create a dead space. Also, protection should be provided at interfaces in the high temperature portions of the system. The vapor-liquid interface has proven to be a critical point.

The first step of our process is high pressure reforming. We have been faced with some erosion losses in piping. While it is too early to determine the tube life in a high pressure reforming furnace, we have been following the condition closely. Ours is a single furnace of some 336 tubes of Kellogg design. At the pressure and temperature of our reforming operation, we feel we are going to have some failures. We do not know just what to expect in the furnace itself.

As you can gather, our inspection has been made on more or less of an annual basis. The inspection this year was early as a result of the strike we had during June, July and August. At the end of the strike period, we completed the turnaround work on the ammonia as well as the other operating units. We are trying to develop our own records on this equipment. We have a group of people who are analyzing the data on record. The data taken are being used to set up a system of records.

In metal inspection, we are perhaps on the conservative side. However, we feel that it is a must for us as we go on with this particular venture. It no doubt will add expense to the operation. We have faced that problem and are providing for it by what we call a "fixit" cost in our initial investment. In that portion of our budget we are then able to absorb the cost of additional downtime and the cost of the inspection. We have accepted a lower "on stream" time and efficiency. However, in order to have a safe and efficient operation of this facility, we are developing a metal inspection program that will be beneficial to our own operation, as well as providing some data for use in future get-togethers of this nature.

Chairman MAUNE: At this time we would like to have discussion from other representatives working in the ammonia plant field or anyone else who might have something to offer at this time.

HOLSTEIN, Atlantic Refining, Phila., Pa.: We too have experienced some cracking metal failures at nipples for safety valve takeoffs and we have attributed these to vibration. I was wondering if you have any particular program for compensating for this vibration in any planned way. Perhaps methods to follow to eliminate your vibration in a systematic manner.

KING, Sohio: We did some engineering work on vibration, and on how to approach the problem. Our principal point of vibration was in the initial part of the synthesis loop, at the point where the circulator outlet and the purified synthesis gas make-up join to go through an oil trap and a series of exchangers. At this point we had a particularly serious vibration problem that was beyond the

WHO TOOK PART

N. H. WALTON,
general foreman, Ammonia Dept., Atlantic Refining Co.

An organizer of this session, Walton spent his first seven years after graduating from the U. of Pennsylvania as an operator at Atlantic, gained respect for safety from the grass roots. With the increase in air and ammonia installations, and several recent fires and explosions, Walton felt the industry could gain much from this discussion, found good cooperation.

H. E. MAUNE,
plant superintendent, Miss. River Chemical Co., Crystal City, Mo.

Also an organizer of this session, Maune spent many years at the TVA ammonia plant at Wilson Dam, has long been known as an expert in the field where he has helped many engineers build and operate other ammonia plants.

R. Bollen, Dow Chemical Co. of Canada, Sarnia, Ont.
J. W. Buddenberg, Collier Carbon & Chemical Corp., Brea, Calif.
R. E. Butikofer, superintendent, Chemical Products Div., Calumet Nitrogen Products Co., Whiting, Ind.
N. A. Carter, asst. production manager, Grand River Chem. Div., Deere & Co., Pryor, Okla.
F. E. De Vry, process engineer, Hercules Powder Co., Wilmington, Del.
A. C. Faatz, process design engineer, Foster Wheeler Corp., New York, N.Y.
A. J. Gorand, safety coordinator, Sun Oil Co., Philadelphia, Pa.
L. B. Henderson, Ammonia Dept., Dow Chemical, Midland, Mich.
O. A. Holstein, operating supervisor, Ammonia Dept., Atlantic Refining, Philadelphia, Pa.
G. E. King, general supt., Sohio Petroleum, Lima, Ohio.
J. A. Lawrence, USI Division, National Distillers & Chemical Corp., Tuscola, Ill.
W. A. Mason, Engineering Dept., Dow, Midland, Mich.
J. E. Ohlson, project engineer, Pennsalt Chemicals Co., Wyandotte, Mich.
R. W. Sanders, supv. of chem. operations, The Texas Co., Lockport, Ill.
D. L. Stockbridge, Jr., Southern Nitrogen Co., Savannah, Ga.
W. F. Super, chief chemist, Nitrogen Division, Allied, Hopewell, Va.
G. Weigers, oxygen supt., American Cyanamid, New Orleans, La.

scope of our engineering staff. We called in an outside engineering firm who provided us with tiedowns and with piping changes in that area. The problem was eliminated. Our metal inspection group at the plant has gone over every vessel, every compressor and every run of pipe looking for vibration. The appendages have been unitized, whether it be a level controller on letdown, a pressure tap on a compressor, or a drain valve on a snubber. Anything else in the way of an appendage has been tied down to the main piece of equipment.

HOLSTEIN, Atlantic: Our problem is complicated in some respects since we have a varied production rate and with variable production the vibration levels are different. When we get the vibration straightened out at one rate and then switch to another, we have the same problem all over again.

BUTIKOFER, Calumet Nitrogen Prods., Whiting, Ind.: I'm interested in the fire you had. I gather that this was a furnace that was processing "syn" gas and is used in the start-up operation of the converter. How serious was the fire and how did you handle it?

KING, Sohio: The fire lasted for exactly 18 minutes. We handled it by blocking in the synthesis loop and by depressuring that portion of the system where the failure occurred. The use of an external heater gives additional valving in the high pressure system. It was through the use of the manifolding in the lines to the external heater, that we were able to block off the system. The pressure was off the furnace loop almost immediately. The damage was slight.

BUTIKOFER, Calumet: Did you use any water to cool the equipment?

KING, Sohio: Yes, we used monitors adjacent to the synthesis structure. They covered the entire structure. The fire burned out in short order.

LAWRENCE, USI, Tuscola, Ill. You said that you tore out your effluent cooler over there. We've never torn out ours with this clean gas. I was wondering what you found on the inside. I understood you to say that your failure was from the outside—from the water. Is that right? Was there anything on the inside or was the inside in excellent shape? So you feel that with this type of clean gas you don't get any erosion problems on the inside.

KING, Sohio: The failure was due to water side corrosion. The interior of the tubes showed no erosion or attack.

LAWRENCE, USI: I think it is similar to yours—almost the same.

FAATZ, Foster-Wheeler, New York: I'd like to ask Mr. King two questions. First, I'd like him to enlarge a bit, if possible, on this erosion which he mentioned as having taken place in the high temperature reformer furnace or at least somewhere in that part of the plant. I don't recall just where he said the erosion occurred. Second, if this vibration he speaks of, which occurred in the high pressure system, was a progressively worsening condition with the passing of time, or was evidenced almost immediately after the fire had occurred.

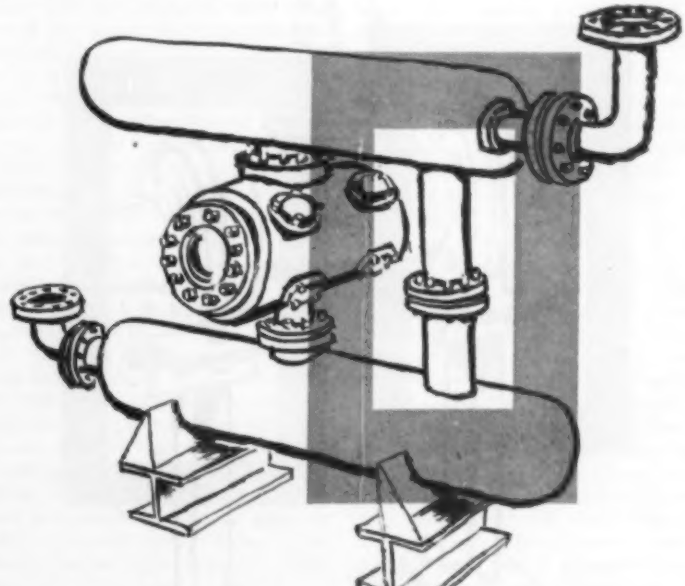
KING, Sohio: In the reforming portion of our plant the erosion occurs in the piping after the secondary reformer. The combustor outlet and the shift converter outlet piping have some evidence of erosion. The vibration problem began on day—1. As soon as we came up on pressure while reducing the synthesis catalyst, we ran into the vibration problem. It was the first serious thing that occurred in the synthesis portion of the plant.

STOCKBRIDGE, Southern Nitrogen Co., Savannah, Ga.: I'd like to ask Mr. King, first, whose compressors you have and then would you give me a general description of them?

KING, Sohio: The compression in our plant is accomplished using a two-stage Ingersoll-Rand centrifugal with a 4000 hp. electric motor driver on raw "syn" gas. The primary compressors are reciprocating Ingersoll-Rand compressors with three stages of compression. We have two of these machines each capable of 55% capacity for a 300-ton plant. Each stage of compression on each machine has two cylinders. The first stage has an 860 lb./sq. in. gauge discharge pressure; the second stage 2200, third stage up to 5000.

STOCKBRIDGE, South. Nitrogen: Would you mind elaborating a little bit on this inspection program you have? Exactly what do you do and how do you do it?

KING, Sohio: Some eight months or so before the plant was completed, our metal inspection group started to develop a set of prints and forms for the records. These were 8½ × 11 prints of all piping and of all vessels. We go into a turnaround with a complete set of working prints on which observations and measurements are entered. This volume becomes the work book. Actually, there are three sections—piping, vessels and safety valves—in the work book. All data in the book are entered on data sheets in the metal inspection files. We progressively plot the changes in metal thickness, in furnace tube elongation or in the physical characteristics of the equipment. We determine areas



Typical pulsation dampener installation on a reciprocating compressor. Shown within the shaded area is a rugged support for the isolation of vibration.

. . . vibration, which causes failures of small connections, is a major problem in most air and ammonia plants, most plants handle it in the same way.

to watch and forecast replacements of equipment using these records.

WALTON, Atlantic Refining, Phila.: I'd like to make a few remarks here. A number of us in the ammonia field are now people who have been in the oil business all our lives and we are accustomed to thinking in terms of yearly inspections of pressure vessels. This, in many respects, is not too practical in the ammonia business where you have a converter that you would not like to take apart every year unless there is some really good reason. We discussed this in what we call our Pressure and Corrosion Committee, which in our refinery is the advisor to the Metal Inspection Committee, and we decided we would not inspect our converter for five years. A method of inspection was left in the air temporarily. We're still considering just what sort of tests we want to apply to it. It's a multilayer vessel and that adds some complications. We did come down after about a year and remove the internals of the converter and at that time rigidly inspected the inside and trepanned out a small sample of the inner layer. We're considering what we should do at the end of five years.

On this vibration problem which has been mentioned we are quite conscious of that and we started off the plant on this basis—that on compressor piping up to the first major vessel, all small connections such as pressure gauge connections, samples, vents, etc., would be constructed using Taylor forge nozzles (a heavy, long welding neck nozzle) and a flanged valve. That has proved to be very satisfactory. However, we found that vibration extends beyond the first vessel and we had some—I guess about six failures altogether—of small connections from piping after that point. So we have reviewed that again and have extended the use of the welding neck nozzles beyond that point with gussets and so on, which Mr. King mentioned. We have our metal inspection people go over all the small connections in the plant once every month to look for cracks and we are still somewhat concerned as to whether we have done as good a job as we should.

The vibration problem seemed to be under pretty good control until we added more equipment in expanding the plant. Then we found we had a completely new vibration problem. This vibration is a very nasty thing. You can stop vibration at one point, of course, and then, as you well know, it becomes transmitted to some other point. So it is our feeling that it is really a problem for the experts as Sohio apparently felt in going back to Kellogg.

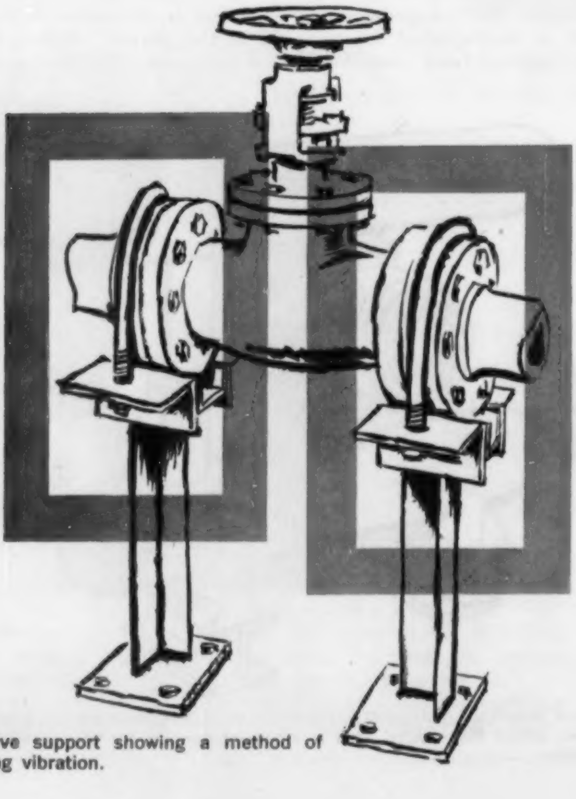
There are various inspection tools, of course—audiogauging, visual inspection, proof testing and others. I think it would be interesting to know whether anybody has set up any basis in his own mind of how he is going to test the major vessels like the converter and the oil filter, and high pressure separator, and how often.

HENDERSON, Dow, Midland, Mich.: With regard to the comments by Mr. King concerning corrosion and failure of high pressure coolers, our solution to that problem is to use copper-clad, extra heavy seamless steel tubing in the coolers. With no corrosion inside the tubing and with copper cladding on the outside, we have coolers that have been in operation 15 years and are still in excellent condition.

For sample points and pressure gauge connections in high pressure service, we use couplings welded on the piping or equipment with American Instrument Co. high pressure valves for control. The valve outlet is connected by rubber tubing to the sample line which runs to the control station. If the tap is used for obtaining pressures, we use ⅛ inch capillary tubing between the valve and the pressure gauge.

Commenting on our setup for testing and inspection, all pop valves are changed and tested at least once each year. High pressure equipment such as converters are hydrostatically tested at 5/3 the operating pressure at 2-year intervals. Other high pressure equipment is tested at 5-year intervals.

WALTON, Atlantic: Speaking for Atlantic, the final responsibility is with our Plant Protection people. The way the system works is something like this: The maintenance people request permission to weld in a certain area or location, or to enter a vessel, whichever the case may be. The op-



Large valve support showing a method of minimizing vibration.

erator then prepares the area in accordance with what in his opinion is the safe and proper manner insofar as clearing the apparatus of gas, or removing refrigerants from the area and so on. Then the plant protection, or safety people are called in and they inspect the area and ask questions and they must be satisfied that it is safe. They then give the permit and for the permit to be valid they must sign it and the operating supervisor in the area must sign it. That makes it a joint responsibility and welding or other work of that nature cannot be done unless they jointly agree, in writing, on a fire permit or a welding permit to do so.

ANONYMOUS: Are your plant protection people technically trained?

WALTON, Atlantic: No, they are not. They are trained mainly in the College of Hard Knocks.

ANONYMOUS: Your safety people then are experienced in operation? Is that right?

WALTON: Yes, to some degree.

GORAND, Sun Oil, Phila.: We differ somewhat. We have our gas testing department but our permits are made out in triplicate. The man doing the hot work keeps one on his person; one is sent to the superintendent's office; the operator keeps the other. The gas tester himself retains the copy in the book. The gas tester's function is to properly interpret the readings of his instruments and to let us know whether or not gas is present and how much. He also has the privilege of making suggestions, based on his experience, if he would like to criticize it. On this form there is a place for him to write down remarks which may contain suggestions. But the end responsibility is placed, we think properly, on the man in charge of the plant, the operator.

HOLSTEIN, Atlantic: I'd like to expand a little on Mr. Walton's statement. He spoke about our major repairs—where we have to enter vessels, etc. We also have the problem of routine maintenance for which we have a resident mechanic group; here we put the responsibility on the operators themselves. If a piece of equipment is to be worked on, there is a work ticket made out and the back of the ticket is stamped with a safety check procedure. Both the shift foreman and the mechanical foreman then go over the work in regard to the safety aspects of the job.

SUPER, Allied Chemical Corp., Hopewell, Va.: Our procedure is quite similar to that which Mr. Walton mentioned. We call in our chemical department also for responsibility in making the necessary clearance tests. They issue a memo which goes along with the burning permit and which gives their statement as to whether conditions are safe to perform the burning or for entering the vessel. The chemical clearance takes in a general survey of the area and the possibility of a dangerous condition developing even though the gas tests may be O.K. I might also add that burning permits are only good for one day and must be reissued every day.

BUDDENBERG, Collier Corp., Brea, Calif.: Our safety procedure is quite like that used by Atlantic, with one exception. We have, for any planned work—that is, work that doesn't come up on the spur of the moment—what we call a "hot work" plan sheet. This is set up in triplicate and is signed by a representative of the Fire & Safety Dept., the Operating Dept., and the Maintenance Dept. Most important, the hot work plan sheet is filled out at least 24 hrs. in advance of the job. We find that this permits it to be seen by responsible people in those departments and it permits a little mulling over the situation so we don't have any unusual incidents because of insufficient planning.

BUTIKOFER, Calumet: We're all in accord with this business of trying to clear the area before you do any work. However, we've had the experience with hydrogen streams at about 125 lb. pressure that even though we close the valves the gas will leak through. We find ourselves trying to change a compressor valve in a hydrogen atmosphere. Now we have taken the stand that if we can change a valve within five minutes, we'll do it. Anything that takes longer we actually blind off. That makes it a good deal more complicated job.

DE VRY, Hercules Powder, Wilmington: In addition to that, we make it a practice in our plants to put a bleed valve between two high pressure block valves so as to stand between high pressure operation and equipment to be worked on so. When the two valves are closed, the bleed is open between them and we can thus be sure that no gas under pressure is leaking past the second valve. This applies to work on equipment where there is a possibility of high pressure leakage past the second valve. Our systems are at approximately 1,000 atm.

WEIGERS, American Cyanamid, Fortier, La.: We feel that the primary responsibility for safety must lie with the operating people because, in our

opinion, they are the ones most familiar with the process hazards involved in hot work. Consequently we ask that any hot work be signed by the shift foreman and also by his immediate supervisor to give a double check and make sure that all process considerations have been taken care of.

With respect to valving off a particularly dangerous gas we make a blanket ruling never to rely on valves if hot work is involved. Any line must be blanked if on one side you have an explosive or a combustible gas and you are working on the other side. Now if there is an argument between the Maintenance Department and the operating group, it will be referred to the Safety Director of the plant for settlement. In other words, any maintenance mechanic can challenge the wisdom of particular safety permits. In fact this happens very rarely.

ANONYMOUS: I know of several instances where people have tried this double block and bleed system and you'd be surprised that the small valves can get plugged up. In my experience and knowledge of other plants I know of places where several bad accidents occurred because they didn't blind. The bleed didn't work and caused failure.

CHAIRMAN MAUNE: We have about 20 minutes left and we now open this meeting to discussion, so that anyone may bring up any subject he wishes.

OHLSEN, Pennsalt Chemicals, Wyandotte, Mich.: We are a little different, I guess, from most of the recent installations. Our reason for doing that was architectural considerations in squaring off an existing building. At the time, the construction which was used was to louvre the area so that there was plenty of air movement on the back side. We had some discussions among ourselves as to continuous monitors to pick up leaks in advance of the big bang, but we could not get any agreement on the subject so we never did it. I was curious as to whether any other organizations in their confined spaces are using continuous monitors to pick up and warn of final gas concentrations shortly after they occur. Of course that's a tough thing to do—to know what is going to leak but it appeared to me that a monitor of 46 points in our monitor room placed strategically might tell us of incipient fires or something of that sort. However, we've never done it. Has anybody

. . . some companies still favor hoses for loading ammonia, others have gone to pipe.

else? Has anyone gone into continuous monitoring?

HENDERSON, Dow: Our high pressure equipment is located outside the building. The parts of the plant that are housed are the low pressure blowers and the compressors. We have had leakage from the packings of the Connersville Blowers handling hydrogen and have installed Johnson Williams industrial gas detectors over each of the blowers and at various points on compressors. At 40% of the Lower Explosive Limit of Hydrogen in Air an alarm is sounded and a panel board light comes on to alert the operator to shut the plant down and correct the leakage.

We were concerned as to whether flashbacks would occur in the instrument which would ignite a flammable mixture. The complete range of hydrogen in air, up to 100% hydrogen, was checked without flashbacks occurring so it is completely safe to operate in an atmosphere containing hydrogen.

BOLLEN, Dow Chemical of Canada, Sarnia, Ont.: We have the same analyzers at Sarnia as at Midland. They are located over our synthesis gas compressors, hydrogen and hydrocarbon compressors, and also over our circulator compressors. We find them very useful for detecting small packing leaks—leaks that might be missed under normal operating conditions. The analyzers are connected to an alarm which rings on the control panel and alerts the operator to the specific area where we have the leak. By testing with a gas analyzer we can pin down the particular compressor cylinder or valve that is causing us the trouble and if it is serious enough, shut down the machine.

GORAND, Sun: We recently built a new unit which is about 350 ft. high, and the site was in juxtaposition to active gas plants and there were many sources of contamination. The whole construction area was literally crawling with welders and a lot of hot work was being done. We invested something between $18 and $20,000 in buying continuous combustible gas alarms. We used the type with rotating selectivity valves at different locations and at different levels. I think we have one or two that were hooked up to a large klaxon that could be heard over and above the hum of the industrial construction noise. These alarms were automatically tested and on one or two occasions when there was an escape of gas the detectors kicked off and all hot work in the area was doused at once. Throughout the construction job we had no serious fires.

So we think the equipment paid for itself because it could be utilized elsewhere not only in permanent locations but as a portable monitor.

For instance—on one occasion when men were working on a spheroid-type tank which was on legs and was some distance above the ground it was placed above a manhole. Of course the valves to the tank sphere were dropped out and all precautionary measures were taken to be safe but we still stuck a "sneak" in there—a nose in there, we call it, and this is what happened (bringing up the theory of the monotony index)—at noontime all men who are welders are supposed to bring their torches out with them—we had some gas welding to do—and they are supposed to disconnect the torch and take their hose out. But you know how men are, especially in the summertime when they are anxious to get out and take advantage of every minute of that noon break. One individual left his torch in there, it had a leaky combustion chamber on it and just before the whistle blew for them to go back to work this monitor picked up and kicked off. Had the men gone into the area and lit their torches, they might have come out of there very rapidly, which proved the value of the equipment.

HOLSTEIN, Atlantic: I'd like to get back to the subject of equipment failures. We've been concerned primarily with the steel equipment in the discussion thus far. However, there is one obvious problem in ammonia plant operation, and in others. You have to sell your product and to ship it, and here you encounter the problem of what types of hoses, the connections, and inspection methods for hoses. Another subject is that of quick couplings; we don't feel that any observed so far are satisfactory and I would like to know if anybody else has experience with quick couplings? Our program is to inspect hoses every six months by a hydrostatic test. As for couplings, we use the "Weco" coarse-threaded union to make the couplings between our hoses and our tank car. Does anybody care to comment on the subject?

CHAIRMAN MAUNE: I might add something to that. In my experience with hose in ammonia service it hasn't been too good. For that reason we have gotten away from it entirely and we use pipe and Chiksan joints which have worked out very satisfactorily. The joints don't leak if you take care of them and lubricate them once in a while and we think it is a pretty good step in the right direction.

BUDDENBERG, Collier: We also use Chiksan joints. We find they are very acceptable. We use them for tank cars. We haven't used them in the truck loading lines as yet.

DE VRY, Hercules: We use air baths with rubber or neoprene hoses and so far we have not experienced any particular trouble with aging or cracking of the hose. We've used them for years, we've replaced a few of them which began to look bad at the connections.

But we use neoprene and I must say neoprene hose works out. I would like to get an expression of opinion from this group about something we've talked about a great deal and can't seem to come to any agreement, at least within our company, and that is the advisability of using an explosion-proof fitting on a thermocouple connection in an area where it is possible to get gas leaks. We have had both sides of the question argued hotly but I personally do not see why one should have to. However, there are those who say it should be done. It amounts to considerable expense in an installation and I just wonder how much real danger there is. Have any of you any thoughts on this?

WALTON, Atlantic: We argued quite a lot between ourselves when the plant was built about the necessity for complete explosion-proof setup and our conclusion was that we would not use explosion-proof fittings for thermocouples wiring and in the laboratory which was within the plant limits, we used vapor-proof construction. We do not ordinarily bring hydrogen into the lab but we do have ammonia in there and the feeling was that the temperature required according to the best sources to be found in the literature, was so high that it was difficult to justify explosion-proof lighting and electrical outlets in the laboratory.

FAATZ, F-W: Most of Foster-Wheeler's plant construction, in fact all of our plant construction in the ammonia field, has been with Texaco partial oxidation, so that's the only field about which I can speak. But a lot of the ammonia plants that are being built have been built to operate with high pressure reforming—furnaces, which operate in the range of 80, up

to, I guess, as far as 125 lb./sq. in. —nobody cares to say just how far. It would certainly be of interest to me, and perhaps to all of us here, if there could be some discussion on what precautions are taken with regard to tube rupture, tube failures, etc., whether there have been any such experiences, and what has been done about them.

STOCKBRIDGE, Sou. Nitrogen: We have a high pressure reformer and we have had some tube ruptures at the bottom of the catalyst tubes which are about 4 in. in diameter. These ruptures start where the gas comes out of the bottom—I believe it's 1-¼ in.; at that weld we've had several ruptures. They haven't been serious. As you know, you can't see the light of a flame very well in the daytime so we have them inspected all the time and we particularly note them at night when the flames can be seen. We haven't had any real serious ruptures because the pressure is not that high. If they aren't too bad we go ahead and operate until we have enough other maintenance, to justify a shutdown and then we have to shut down and reweld.

We have had a rather lengthy shutdown in which we went over and rewelded the whole batch of 150 tubes. We had no trouble with ruptures but we considered it advisable to strengthen those welds and since that time we haven't had any trouble with ruptures at that point.

CARTER, Grand River Chem. Co., Pryor, Okla.: I'd like to go back to this point of thermocouples—lead wires into the instrument. I have observed on one occasion where hydrogen at high temperatures was being handled at low pressure and you could almost always find explosive gas tests if we checked the thermocouple well. So I do think there is a potential hazard, if the thermocouple is piped from the thermocouple well directly into the instrument; it was our practice on our recent plant not to run the conduit to the head of the thermocouple. We have a loop exposed there so there is no way in which hydrogen gas could be led into the instrument. We felt we would bring a potential bomb right into the control board in so doing, where we operate at higher temperatures.

CHAIRMAN MAUNE: I think we should move on to another subject now. There is one that is always with us or has been in the past—I think it is here all the time—that is the internals of an ammonia converter or anywhere where you have high temperature and pressure and nitrogen present. The nitriding problem has been quite serious in the past. There have been some developments—there are still some going on which have greatly helped the situation. I can remember when I first got into the ammonia business, my old boss told me that whenever you pull the catalyst basket out of the converter you're just apt to take it out in pieces. You just can't pull it out in one unit.

Back in those early days there weren't the alloys we are working with now to make the internals, the heaters, the baskets, and so on. Of course in extended runs and operation of an ammonia plant, especially the converter, we like to keep them on as long as we can. My experience has been with one converter which operated 8½ yrs. without opening, and another for 7½ yrs., until there was evidence of nitriding and peel.

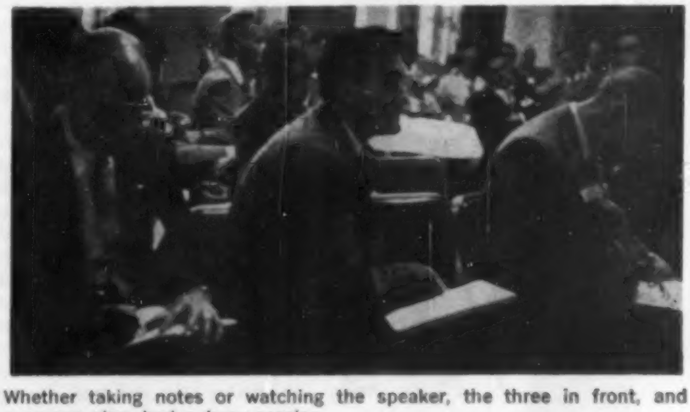
I have no formal presentation at this time but a gentleman came up and brought some specimens of nitrided steel and I wonder if he would come forward now and say a few words and maybe he would like to identify them or talk about the way they would affect his operation in the safety area when operating an ammonia plant.

BUDDENBERG, Collier: I brought along a tube sheet and a portion of a tube from the methanator-exchanger in our synthesis loop which operates at 3,000 lb. We had a rather severe case of nitriding—at least it was so analyzed by our metallurgist. The tubes involved were 18 gauge, 5% chrome, ½% moly in composition. The tube sheets and cross baffles had the worst nitriding and they were 12% chrome. The examples are here on the table if you care to examine them. You will note that the cross baffles are very severely corroded—actually they were completely disintegrated in the top 3 or 4. The temperature at this point runs at a maximum of about 850°F. Our converter has internal exchange so that the exit gas is already somewhat cooled.

I have a few comments on the previous subject if they are suitable here too. We also had a nipple failure in a high pressure system, depressuring the system through a ¼ in. nipple. We attributed it to vibration at the compressors (where most of our vibration has occurred). We think we now have the problem solved. We have used the usual methods of unitizing down the nipples as described by others here. In addition, we have done a better job of tieing the piping in the compressor area down to the concrete and we have installed pulsation dampener tubes within the discharge bottles of some of the compressors.

We had one other failure in our synthesis system which might be of note. We have a methanator ahead of our synthesis loop; several depressurings at high rate during various operating difficulties caused the catalyst in the methanator to fragment and some of the fragments went through the support screen. In making the turn in the piping at the bottom of the methanator these fragments severely eroded the piping. A failure occurred at the elbow and enough of the hydrogen-nitrogen mixture leaked to flash and burn. We fought the fire in the same manner as that described by Mr. King—depressured the system and flooded it with nitrogen; the whole affair was over in about five minutes.

To combat this problem we changed to a stainless pipe at that point and also made a wide radius curve from the methanator. We've



Whether taking notes or watching the speaker, the three in front, and everyone else, had a busy session.

. . . a tragic experience involving a broken tail rod requires drastic measures to prevent a recurrence of the same accident.

had no more trouble and our inspection indicates that the metal is still full thickness.

CHAIRMAN MAUNE: Are there any other comments on nitriding problems? There is one thing I would like to bring up at this time because I've experienced it myself and I think that everyone would like to hear about it. I'd like to pass it on to you because if there is anything you can get out of it, or profit by it, it would be very worthwhile. It is about a serious accident we had in our plant at the Mississippi River Chemical Co. over a year ago. It involved a syn-gas high pressure compressor. We compress syn gas to 9,000 lb. pressure in four stages. The last stage cylinder is a double-acting piston with a tail rod. Of course the old conventional way of covering tail rods to keep down or vent off the leakage from the packing or catch the oil drip is merely to put a piece of schedule 40 pipe or so over the rod—also for protection against personnel getting into the way of the rod. This particular compressor had been operating I would imagine for about sixty days or perhaps between 45 and 60 days.

The story was this: we were starting the reaction in both of our ammonia converters. We were at a point where we were producing and just lining out the loop. It so happens our control panel was right in a direct line with the end of this compressor cylinder. Conditions were very well stabilized. We had three people in front of the panel—our ammonia superintendent, our shift foreman and an operator, and for no apparent reason at that time, the tail rod broke off inside the cylinder and of course the tail rod came flying out of the end and hitting a building beam about 40 ft. away. We were at 8,000 lb. pressure at that time. There was nothing to prevent the gas from coming out of the cylinder. The compressor ran for about a minute or so before we could shut off the compressor. The gas ignited and filled the whole building—that end of the building—with gas. It literally blew out the end of the building, blew three men out and burned them.

Now there is quite a bit that we have learned about that situation. We investigated every possible angle of "why did it happen." This compressor piston rod is made of a Nitralloy material which is a very high tensile steel. In fact we are told it is one of the best materials made for use as rods of that sort. The rods are actually about 12 ft. long, 3 in. in diameter, and we made various tests and when we got the pieces together the tailend rod was literally full of cracks. There were hairline cracks, others that were halfway through, quarter-way through—just full of them.

We have developed information which we think might have caused the break in this rod. That particular rod was damaged in the earlier stages of operation, we needed to get on stream, the rod was damaged in going through the bushings and the runout was in excess, so steps were taken to straighten the rod and regrind the surface that had been damaged going through the packing bushings. We found out later that this Nitralloy material is very tricky stuff —you can't grind it—and when you do grind it you produce surface cracks. So that is the information we have developed on why the rod failed. We thought we still had a problem there —we didn't want any more tail rods flying around. So we worked with other people. Our engineering group and Cooper-Bessemer came up with an idea of putting a catcher over the tail rod. It was something I had never heard of before but I understand others have successfully used it in the past. What it involves is taking the schedule 40 pipe off the tail rod, cover, and actually getting a steel forging machined which bolts right next to the packing case. It is designed to withstand the full pressure which is inside the cylinder.

There is a leakoff connection—the normal leakoff from packing can get by. If the leakoff should develop so it gets to 50 lb. pressure, we have a pressure alarm on it which would sound an alarm and we'd know that something was causing gas to get back into the catcher in excess of normal leakage.

Another thing we did was to bore the tail end of the rod. We have a hollow rod. From the end of the rod all the way to the piston there is a 1 in. hole. The reason for that is this: if a crack were to develop, or a break, the pressure would immediately equalize going through the crack down through the bore and back through the catcher. We think that might improve conditions in case the rod were to break. Also, in the end of the catcher on the inside, we have a lead block which will absorb shock when the rod breaks. We don't think it would go back real fast. Also, where the flange of the catcher bolts to the packing case there is a bronze bushing which is of a smaller diameter than the outside diameter of the piston rod. There is about 2 to 3/1000ths interference there which is another means of slowing the rod down when going through the bushing and before it gets to the end. I think it is worthy of passing this on to you. I don't know if any of you people have tail rods on any of your compressors. You probably do. This is my first occasion of using

a rod of this type at this pressure—9,000 lb. I've used them before at 3,000 lb. and at 5,000 lb. Of course those particular rods were larger diameters—say 4 in. Whether this has any effect on it—whether the long rod or the smaller diameter or the higher pressure, I don't know. However, if anyone cares to comment on that I'd be glad to hear him. Possibly somebody else has experience along that line and if so, I'd like to have the benefit of it.

I'd like to get comments from somebody, especially on the rods. If you have a damaged rod which is bent when the runout is too great, has anybody set up any limits on the maximum amounts of runout? Or do you try to reclaim a rod by straightening it, or scrapping it, or just what.

HOLSTEIN, Atlantic: Based on your experience (we also have tail rods on some of our compressors) we have actively engaged in plans for tail-rod guards. One of our worries is the alarm system that you mentioned. Have you experienced any difficulty in being able to set the pressure alarm due to the reciprocating action in the compressor?

CHAIRMAN MAUNE: We haven't had any difficulty along these lines. Actually, the way it is arranged is this: on the bottom of the catcher we have a spring-loaded check valve. Should the pressure get to 50 lb. of course it will shut off and once your spring-loaded valve closes your pressure will increase. You can set the pressure at any spot on the dial you want to. What we have is one we had built which will go to the full 9,000 lb. What we have is a pressure transmitter located right at the face of the cylinder. Many pulsations or fluctuations in pressure at that point wouldn't affect the alarm any. We also have a bleed valve there whereby the operator can go by, say, once an hour or so, and open it up and check it himself. He just opens it up and normally there is very little gas coming out if the packing is all right.

Here is another item I think we should talk about. It concerns high pressure welding. Any welding failures we might have, any welding inspections, magnofluxing, reflectoscope, things of that nature.

CARTER, Grand River: Our experience occurred after approximately one year's operation. We had a high pressure exchanger—this is on a synthesis gas compressor which failed at a weld on the return bend on the exchanger. The result was that it depressured this exchanger into the cooling water stream which went back to the cooling tower. The only damage other than to the exchanger was to cause the riser on the side of the cooling tower to tear away from the tower and fall to the ground. Visual inspection of the welds of this exchanger did not look good. We elected then to have all of the welds x-rayed. Some 70% of the welds in this exchanger would not pass x-ray inspection. They had voids and slag inclusion in them. Of course the result was rewelding some 70% of the welds and stress relieving them before we could put the exchanger back in service. This exchanger, of course, was built under code and with insurance inspection. The purchase order did not require that all welds be X-rayed, and I thought it might be well to bring this up for discussion to see what the experience of other companies has been with high pressure exchangers. I would say this, without mentioning the name of the exchanger company, that it did not exercise what we consider the proper concern about the failure of a weld or the fact that some 70% of their welds were faulty.

ANONYMOUS: I can add a little something to this business of weld failure but a little different kind of an incident. We have in our nitrogen wash operation a very low temperature and in operating upsets some of our steel lines are cooled off rather drastically. In so doing we have had the experience of a weld failing and usually at a slag inclusion. The split in the pipe is usually of a spiral nature. It starts at the weld and then splits right through the virgin metal.

ANONYMOUS: I'd be very interested to hear if anyone else had an experience like this with low temperature piping. Particularly whether anyone else has had experiences like this with low temperature steel piping. This is something that concerns us very much and it is news particularly to a group of petroleum men.

HOLSTEIN, Atlantic: We have experienced the same type of failure in our cold blowdown system where we let down some cold materials into a blowdown header. Carbon steel is not satisfactory material for a very low temperature process.

ANONYMOUS: (Question is asked on compression inspections.)

WEIGERS, Cyanamid: We've been arguing about this subject for the last four years. Right now we are operating eight steam turbine driven centrifugals and we are putting seven more on the line. We've come down to this system now. We make an annual inspection—what we term an "at rest" inspection of only the bearings, the governors, and the various auxiliaries of the machines. Every three years we are planning to lift the cases on them. Maybe we'll find as we follow the program of three year inspections that this is too frequent or possibly not frequent enough. We are starting off with a one and three program.

WALTON, Atlantic: Atlantic checked Cyanamid's practice of three and that is about the frequency with which we inspect turbines. Of course if you have a vibration setup some time which is excessive, why naturally you look then.

There is one topic that I'm not sure everyone is aware of and that is this —that is the question of velocity checks in tank cars. At the moment there is no regulation which requires velocity checks in tank cars. When we started operations one of our customers specifically requested that the velocity check be removed from tank cars to help unload the cars more quickly. I believe that recently there are some proceedings before the ICC which are becoming crystallized now and which will require velocity checks to be used in all tank cars and tank trucks in interstate service. That may be of some interest to you. Also if you have any feelings one way or the other, you might care to get in touch with the regulatory authorities. The customer who requires the velocity check to be removed from tank cars going to him has been talked out of that by ourselves, and we have insisted that all tank cars leaving our plant have velocity checks in them. Does anybody have any comments on that?

MASON, Dow, Midland, Mich.: I would like to ask Mr. Walton at what velocity these check valves are designed to close?

WALTON: I can't answer that. Of course the cars used for ammonia are usually interchangeable between ammonia and LPG, and we have never gone into the matter of just how they are set. The people we lease tank cars from are Union Tank Car Co., and it is whatever their standard installation is.

DE VRY, Hercules: We use a plug valve of that type made by York, that works very well. We have them in all our cars and we have them of such size that a car can be unloaded in an hour which is pretty fast and which is a pretty fair average for a car of anhydrous. All our cars are equipped that way because we have often had to go out and explain what is wrong, to customers, when they can't unload sometimes. However, we wouldn't take them off even though we might lose a sale.

CHAIRMAN MAUNE: We're coming to the end of this session, gentlemen,

and if there is anyone present who would like to bring up something else we still have a few more minutes.

ANONYMOUS: We have not considered testing cylinders but it is an interesting problem to consider.

KING, Sohio: On initial construction, Sohio hydrostatically tested the piping and compressor cylinders as a unit.

MASON, Dow (Midland): Several years ago, we attempted to apply hydraulic tests to compressors' cylinders in Midland and ran into considerable difficulty. We tested the discharge line, discharge port, and cylinder back to the inlet valves, at 1½ times the maximum discharge pressure. We also tested the inlet line and inlet port at 1½ times the maximum inlet pressure. Although we did manage to reach these pressures in spite of leakage at the packings, we recognized that these tests did not simulate actual operating conditions. The operating temperature range and distribution could not be simulated. Therefore, the stress distribution was not representative of operating conditions. Any possible failure of a cylinder in operation would be a fatigue type, which would be progressive rather than sudden. Such failures always give warning by leakage. Consequently, we believe that periodic hydraulic testing of the compressor cylinders is not justified, and we have abandoned any further hydraulic tests.

BUTIKOFER, Calumet: One safety problem gives us quite a bit of concern. It's a matter of oxygen in ammonia. We are not so concerned about the oxygen itself in the ammonia, but as the vapor ammonia and the oxygen pass back through the ammonia recovery system, the tendency is, of course, to condense the ammonia away from the inerts. A mixture like that always contains hydrogen and it is possible to finally have a mixture which is very rich in hydrogen and quite rich in oxygen. An explosion in the ammonia recovery system of the plant can occur. Anybody else thought about this and if you have, what has been done?

WALTON, Atlantic: It looks like there are an awful lot of unanswered questions here that should give us all a lot of food for thought. There is one other thing I'd like to mention which would be of interest to the group. A number of our smaller customers have recently been requesting that we pressure tank cars and tank trucks with nitrogen to help them unload the cars more easily. Presumably they are not equipped with a compressor system for unloading. It seems like a rather innocuous request but when you stop to consider it you are doing away, in a sense, with the safety valve protection for the tank truck or tank car that's been calculated, considering only the vapor pressure of the ammonia in the car or truck. So, if you add additional pressure from nitrogen it is conceivable that if the car or truck sits around in the sun for a long while and warms up, you may have a serious discharge of ammonia from the safety valve which wouldn't make the railroad people or the population in that vicinity very happy, let alone your company. I don't know whether anybody else has had such requests or has considered the legalities of it. We are doing this right now.

SUPER, Allied: We have such requests but we give them the pressure by giving them warmer ammonia in the car. The higher vapor pressure of the warm ammonia produces a higher pressure in the car.

BOLLEN, Dow (Canada): We too have had several requests from smaller companies to pressure tank cars of ammonia with nitrogen and we have complied with these requests. However, we pressure the tank cars according to a sliding maximum pressure scale which we have developed. This scale is based upon the time of year and the prevailing temperature conditions in the areas of the country to which the cars are shipped. In this way we make sure the total pressure in the tank car is kept well below the setting of the safety valve on the tank car.

HENDERSON, Dow (Midland): We have had requests for nitrogen padding on cars, but only in winter when the vapor pressure in the car is low. Our top padding pressure is 100 lb./sq. in., so we are away below the pop valve setting of 225.

One question that I have is in regard to tank trucks for ammonia. The question is before the Compressed Gas Association now and concerns the use of tanks of 250-lb. design pressure. Present ICC regulations require a design pressure of 265 lb.

ANONYMOUS: I want to address this to the earlier speaker about the oxygen contamination in the car. I'm not certain of the gas stream he is talking about. But if he is not interested in the hydrogen contained in that stream could you not just pass that stream through a deoxo unit? This is actually what you can do if you are using an ammonia dissociator to give you a hydrogen gas for desulfurization or something like that. You will actually react the oxygen in the stream with the hydrogen.

Does the stream you were talking about contain hydrogen which has to be saved, or can you just go ahead and destroy it?

BUTIKOFER, Calumet: I don't think I made myself too clear. I was thinking about this sort of situation: when a tank car of ammonia is loaded, the car is usually vented back to the sphere. Suppose a new car comes in or one that has been cleaned, you can get air into the sphere. Now that sphere is refrigerated by compression. The air, along with the ammonia, is drawn down to the refrigeration compressor and the ammonia is condensed.

Now all of the ammonia we've ever had in our spheres has had hydrogen with it. We have always found hydrogen above the ammonia in the vapor space. When that ammonia is condensed, then the concentration of hydrogen and oxygen increases and you can get into the explosive limits. Now some plants, and particularly ours, are set with a pressure controller to release the inert gas out into our sweet gas vent header, which in turn goes to the flare. You can see we could release a combustible mixture of gas right into our flare line and that could flash back. We've had to make some changes to avoid putting it into the flare system. This is a problem where you can have a part of the ammonia refrigeration equipment with inerts that are explosive and I wondered whether this had been recognized by others, and if so, what precautionary measures they might have taken.

WALTON, Atlantic: I might mention that at Atlantic we are fortunate in having a nitrogen plant and we make a practice of purging all new tank cars when they come in. We also make a practice of purging our spheres with nitrogen before we go into them, and when we shop a car, we purge with nitrogen before the car goes into the shop.

CHAIRMAN MAUNE: This is the first session of this Air-Ammonia Plant group. This will end the session of this particular group for this morning. Tomorrow there will be two sessions on air plants, which will probably include air plants as such, liquid nitrogen scrubbing units and even the compressor end of compressing air in air purification systems.

Source of information for illustrations on pages 37 and 38 is the M. W. Kellogg Co.

Parts 2 and 3—Air Plant Safety—will appear in August CEP.

Preparation and properties of **unsymmetrical dimethylhydrazine**

Hard to pronounce but with potentials easily appreciated, unsymmetrical dimethylhydrazine, discussed in the accompanying article, is unique among hydrazines in possessing complete miscibility with water. What is of even more interest is its promise, due to the combination of reducing and solvent properties, and its applications in antioxidants, paint antiskinning, and fuel additives.

Courtesy U. S. Army

The launching of Jupiter C missile on January 31, 1958 carried Explorer 1 Satellite—the first U.S. satellite. As a propellant UDMH has been used in blends with other fuels such as hydrocarbons to promote smooth burning. UDMH has been employed in the Army's "Nike," and the Navy's "Vanguard."

W. G. Strunk

*Westvaco Chlor--Alkali Division**
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For some time it has been known that hydrazine has excellent rocket propellant characteristics. However, some of its physical properties, such as high freezing point and a tendency to decompose at times, are not as good as could be desired.

In the early 1950's the Government sponsored an investigation of derivatives of hydrazine and other compounds which might possess the desired propellant features of hydrazine but without some of its disadvantageous physical properties. The choice resulting from this research was unsymmetrical dimethylhydrazine, which has a low freezing point, excellent stability, good propellant qualifications, and ready synthesis from abundant raw materials.

Westvaco Chlor-Alkali Division of Food Machinery and Chemical Corporation has been manufacturing Dimazine (Westvaco-brand unsymmetrical dimethylhydrazine) since 1954.*

Like other newly developed commercial chemicals, UDMH has been known for some time. Fisher reported its preparation in 1875 *(1)* using zinc and acetic acid to reduce *n*-nitrosodimethylamine which was prepared from dimethylamine and nitrous acid.

$$(CH_3)_2NH + HONO \longrightarrow (CH_3)_2NNO + H_2O \quad \ldots (1)$$

$$(CH_3)_2NNO + [H] \xrightarrow[\text{acid}]{\text{metal}} (CH_3)_2NNH_2 + H_2O \quad \ldots (2)$$

Seventy years later, Hatt *(2)* described a modification of the Fisher method. Current Westvaco commercial process is patterned after that described by these earlier investigators.

Another process that can be used

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* A frequently used abbreviation for the tongue-twisting name, unsymmetrical-dimethylhydrazine, is UDMH., which will be used in this article.

. . . UDMH, its properties make it stable in storage at ambient temperatures, permit it to be a liquid fuel for ready missiles.

to prepare UDMH is a modification of the Raschig process currently used commercially to prepare hydrazine. In the Raschig process, sodium hypochlorite solution and ammonia are combined to give chloramine, in turn reacted with more ammonia to produce hydrazine. Substitution of dimethylamine for ammonia in the reaction with chloramine produces UDMH.

$$NH_3 + NaOCl \longrightarrow NH_2Cl + NaOH \quad \ldots (3)$$

$$NH_2Cl + (CH_3)_2NH + NaOH \longrightarrow (CH_3)_2NNH_2 + NaCl + H_2O \quad \ldots (4)$$

Investigation of this process has been described *(3, 4)* by Audrieth and his coworkers at the University of Illinois.

One of the more interesting innovations reported in the last several years involves the direct chlorination of ammonia to form chloramine rather than the use of aqueous sodium hypochlorite as practiced in the traditional Raschig process. Various techniques for this reaction are described by Sisler and his coworkers at Ohio State *(5)* and Haller of Olin Mathieson *(6, 7)*. Sisler *(8)* reported UDMH yields of 71% by reaction of dimethylamine with chloramine, obtained by direct chlorination techniques.

$$2NH_3 + Cl_2 \longrightarrow NH_2Cl + NH_4Cl \quad \ldots (5)$$

$$NH_2Cl + (CH_3)_2NH + NaOH \longrightarrow (CH_3)_2NNH_2 + NaCl + H_2O \quad \ldots (6)$$

A general method for making substituted hydrazines is the alkylation of hydrazine itself with an alkyl halide or alkyl sulfate *(9)*. This reaction has been used to prepare a wide variety of products.

$$2RCl + NH_2NH_2 \longrightarrow R_2NNH_2 + 2HCl \quad \ldots (7)$$

Its practicality, however, as a commercial synthesis for any single compound is limited by the fact that the reaction tends to give a mixture of products. Another deterrent is the relatively high cost of the starting material, hydrazine.

Other somewhat more exotic syntheses of substituted hydrazines involve hypochlorite oxidation of *n*-alkyl ureas and hydrogenation of hydrazones and azines *(10)*. These routes are probably of little commercial significance in the preparation of UDMH.

Physical properties

As noted earlier, one of the key physical properties of UDMH is its low freezing point of −71°F. This freezing point permits its storage as a liquid fuel for ready missiles, with no danger of freezing at any expected operating temperatures. Some of the other key physical properties are shown in Table 1. At room temperature UDMH is miscible in all proportions with water and with most organic solvents including petroleum fuels.

A flammable material, UDMH has a flash point around 34°F. and wide flammable limits ranging from 2.5 to 95 vol. % in air. The spontaneous ignition temperature in air is 482°F. This chemical is not shock sensitive. In work done by the Bureau of Mines, it was shown that UDMH could not be detonated in cenventional card-gap tests. This was true even when UDMH was deliberately contaminated with materials such as rust, copper, magnesium turnings, and aluminum powder which can be considered potential sensitizers for this type of compound.

Table 1. Physical Properties of UDMH

PROPERTY	METRIC	ENGLISH
Molecular weight	60.08	60.08
Specific gravity	0.784 (25/4°C.)	0.795 (60/60°F.)
Density	0.784/g./ml @ 25°C.	6.64 lb./gal. @ 60°F.
Coefficient of expansion	0.00133/°C. @ 25°C.	0.0074/°F. @ 60°F.
Boiling point	63°C.	146°F.
Freezing point	-57.2°C.	-71.0°F.
Vapor pressure	157 mm. @ 25°C.	98 mm. @ 60°F.
Viscosity	0.509 centipoise @ 25°C.	0.586 centipoise @ 60° F.
Flash point (tag closed cup)	1°C.	34°F.
Heat capacity (liquid)	39.2 cal./g. mole-°C. @ 25°C.	0.653 B.t.u./lb.-°F. @ 77°F.
Entropy		
Liquid	48.86 cal./g. mole-°C. @ 25°C.	0.797 B.t.u./lb.-°F. @ 77°F.
Gas	72.8 cal./g. mole-°C. @ 25°C.	1.212 B.t.u./lb.-°F. @ 77°F.
Heat of formation (liquid)	-12.7 kcal./mole @ 25°C.	-381 B.t.u./lb. @ 77°F.
Combustion	473 kcal./mole	14,200 B.t.u./lb.
Fusion (at f.p.)	2.41 kcal./mole	72 B.t.u./lb.
Vaporization (at b.p.)	8.37 kcal./mole @ 25°C.	251 B.t.u./lb. @ 77°F.
Thermal conductivity (liquid)	0.00048 cal./sec-sqcm-°C./cm. @ 25°C.	0.12 B.t.u./hr.-sqft-°F/ft. @ 77°F.
Surface tension	28 dynes/cm. @ 25°C.	0.0019 lb./ft. @ 77°F.
Refractive index	1.4058 (N_D25°C.)	
Compressibility		
Adiabatic	8.06×10^{-6} sq.cm./g. @ 25°C.	5.69×10^{-6} sq.in./lb. @ 77°F.
Isothermal	10.00×10^{-6} @ 25°C.	7.05×10^{-6} sq.in./lb. @ 77°F.
Critical constants		
Temperature	249°C.	480°F.
Pressure	60 Atm.	880 lb./sq.in. abs.

Chemical properties

A mildly alkaline chemical and (as is characteristic of all hydrazines) a good reducing agent, UDMH reacts with carbon dioxide to form a solid salt. Extended exposure of UDMH to air or other carbon dioxide-containing gases can eventually precipitate the material. Of interest is its slow oxidation in contact with air or other oxygen-containing gases.

Storage and handling

UDMH is quite stable in storage at ambient temperatures. Westvaco's storage and handling equipment, including central storage facilities, shipping drums, and tank cars are made of mild steel. UDMH has been stored in shipping drums (ICC-17C mild-steel, nonreturnable drums) for periods of over a year without deterioration of the physical properties, evidence of corrosion, or pressure build-up in the drums. As a matter of fact, the drums were in excellent condition because the chemical tends to behave as a corrosion inhibitor probably as a result of its oxygen-scavenging power.

Materials of construction

Metals. UDMH is compatible with and may be stored in most common metals under a variety of conditions. In Westvaco, processing, storage, and shipment equipment is made of mild steel. No known limitation exists on the use of nickel, Monel, or types 303, 304, 316, 321, and 347 stainless steel in contact with UDMH. Aluminum and its alloys and magnesium (Dow metal 032) are good. Some attack of

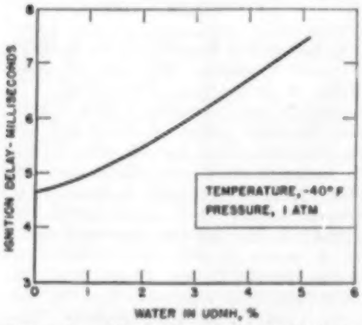

Figure 1. Effect of water in UDMH on ignition delay with IRFNA.

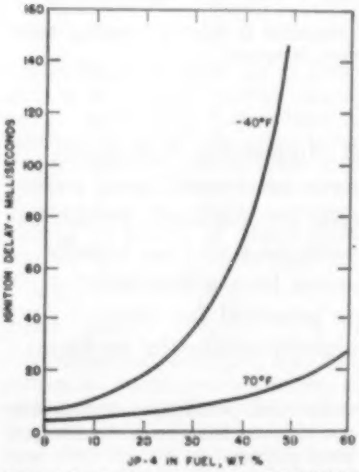

Figure 2. Ignition delay of JP-4/UDMH mixtures with IRFNA.

aluminum has been noted by dilute aqueous solutions of UDMH but no corrosion was experienced at several per cent water. It should be noted that Dimazine typically contains less than 0.2% H_2O. As is customary for ammonia and amines, copper and high-copper alloys are not recommended unless they are proven satisfactory under the specific use conditions.

Elastomers. Due to its solvent properties, UDMH tends to exert a swelling and softening effect on most elastomeric materials of construction. Those which are essentially inert in contact with UDMH are Teflon* and unplasticized Kel-F†. Polyethylene and Hydropol ‡ rubber are also good. A variety of other elastomers, particularly certain butyl rubbers, are serviceable under certain circumstances.

* E. I. Du Pont de Nemours & Company, Wilmington, Delaware

† Minnesota Mining and Manufacturing Company, St. Paul, Minnesota

‡ Phillips Petroleum Co., Bartlesville, Oklahoma

Fire hazards and fire-fighting methods

As noted earlier, UDMH is flammable. Open fires and sources of sparking should be avoided. All equipment in which it is handled should be electrically grounded. Explosion-proof wiring, lighting, and motors are indicated for handling areas. Whenever UDMH is handled under air, a flammable mixture is present in the vapor space. As a safety consideration, the use of a nitrogen atmosphere over UDMH is recommended. Fires caused by this chemical should be combatted with large volumes of water, which achieves both dilution and cooling effects. Liquid UDMH burns smoothly and cleanly, and is readily extinguished on dilution with two or more volumes of water per volume of UDMH. Much higher UDMH concentrations in water will support combustion, although flame intensity is progressively weakened as the UDMH concentration of the solution is lowered. It should be remembered that UDMH is readily miscible with water in all proportions.

Carbon dioxide is also effective in extinguishing UDMH fires. Chemical foams are not recommended since UDMH tends to deactivate the foam-forming surfactant and to destabilize the foam.

Toxicity

The acute toxicity of this chemical is similar to hydrazine, and moderate care must be exercised in its handling. Westvaco has now been producing substantial amounts for several years, and has had no cases of acute poisoning or evidence of chronic poisoning. Its medical surveillance program includes a preexposure physical examination, and personnel exhibiting anemia or evidence of liver disease are not used on the operation. Hemoglobin and white blood-cell counts are made at intervals of six weeks.

The safety precautions recommended for Westvaco's operators are as follows:

1. If the odor of UDMH is apparent, use a respirator equipped with an ammonia canister.
2. Wear splash-proof goggles and vinyl-coated gloves. If possibility of gross splashes exists, suitable splash-proof garments are recommended.
3. If splashes do occur, wash thoroughly with water and launder clothing and other protective equipment before reuse.

Complete studies on the acute toxicity have been made at, or under contract to, the Army Chemical Center and it is currently studying the effects of chronic exposure.

Military use

Most liquid propellant systems used in rocket propulsion are bipropellants, that is, an oxidizer and a fuel are burned in the combustion chamber to provide energy. One of the important liquid oxidizers is fuming nitric acid with a small amount of corrosion inhibitor added to facilitate storage. This material is commonly referred to as IRFNA and, because it can be stored successfully, it is especially useful in so-called ready missiles which must be fired with a minimum of preparation.

In firing a rocket, it is important that combustion be initiated promptly when the propellants are fed into the combustion chamber. If this is not accomplished, an excessive amount of propellant may accumulate in the combustion chamber which can then result in an explosion. One method of minimizing the ignition delay problem is the use of a propellant pair which ignites spontaneously on contact. This property is known to the rocket industry as hypergolicity. The system UDMH-IRFNA is hypergolic with an ignition delay of only a few milliseconds, which is the lowest delay known for any hypergolic system.

The hypergolic character of UDMH is utilized in a variety of ways. Propellant systems using only UDMH and IRFNA have been operated successfully. In other systems, a "lead slug" of the chemical gives reliable ignition to another nonhypergolic fuel system. UDMH has been used in blends with other fuels such as hydrocarbons to promote smooth burning. Some rocket systems using UDMH include the Army's "Nike," the Air Force's "Rascal" and the Navy's "Vanguard."

UDMH is not hypergolic with liquid oxygen but once combustion has been initiated by conventional methods, smooth burning with good propellant qualities is obtained.

The results of a study of the hypergolicity of UDMH with IRFNA were reported by Potter and Byington at a meeting of the American Rocket Society, Sept. 1956. They reported the following conclusions:

1. At atmospheric pressure, the ignition delay of UDMH in fuming nitric acid is short—of the order of a few milliseconds.

2. Dilution of UDMH up to 5 wt.

continued on next page

UDMH *continued*

% of water increases the ignition delay a small amount at −40°F. (Figure 1)

3. Temperature, over a range of −65° to 100°F., has little effect on the ignition delay of the UDMH-IRFNA system. Dilution with jet fuel (JP-4) increases the ignition delay only modestly at 70°F. with a value of 30 msec. observed for a blend containing 40 wt. % UDMH (Figure 2). At −40°F., the ignition delay of these blends rises rather sharply as the concentration of the chemical is reduced.

Costs

The price of UDMH has been steadily decreasing over the relatively short time it has been in commercial production. Prior to 1954, the price was about \$15.00 to \$30.00/lb. In 1954, Westvaco's average sales price was about \$4.50/lb. In 1955 and 1956, this value was reduced to less than \$4.00 and less than \$3.00/lb. respectively. Currently the price for tank-car quantities is under \$2.00/lb.

Westvaco's engineering studies indicate that a selling price as low as \$.50/lb. should be possible if large-scale, sustained production could be achieved. This price includes amortization of the investment and a modest profit that a private company would be required to make. Omission of these components, by way of a government-owned and -operated facility, would lead to lower cost values.

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Presented at A.I.Ch.E. meeting, Baltimore, Maryland.

Acetic acid recovery methods

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Efficient chemical engineering techniques developed to recover acetic acid from water and other materials by standard production methods, can recover the acid from liquors regarded as nuisances, have a flexibility which makes them practical for other industries with mixture separation problems.

OVER 3,000 TONS OF THE MOST common organic acid, *acetic*, are produced in the United States yearly. As an intermediate in many processes with its anhydride and other acetal compounds, it is often used by its producer without entering into commerce. Therefore, its statistics are obscure. A tremendous amount of by-product acetic acid is lost as vapor, or in dilute, highly impure aqueous solutions of the acid, or its salts. Acetic acid results from carbonization and chemical treatment of wood. Recently it has been recognized that a large tonnage is lost in black liquors from wood pulping. Other components of such liquors are salts of other organic and inorganic acids, and organic polymers, or colloids. These may deteriorate into materials even more disagreeable to handle.

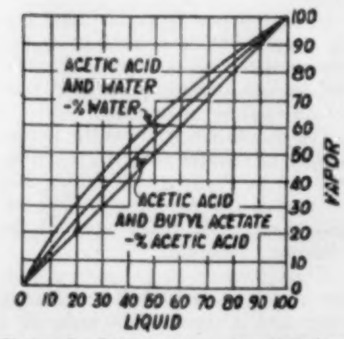

Figure 1. Composition of vapors from solutions of acetic acid and water, and of acetic acid and butyl acetate.

The separation of acetic acid from aqueous solutions has been industrially important for a century. Chemical methods were first used because of the difficulty of distillation. But with improved chemical engineering techniques during the past seventy-five years, physical separation has become feasible. These physical separations are of interest because of the industrial value in producing or recovering acetic acid economically, and for their novelty as new chemical engineering operations—often used since in the separation of other liquids.

Industrial applications

Natural sources

Acetic acid is derived from natural carbohydrates: vinegar (since antiquity) from biochemical oxidation of alcohol, fermented from sugars: pyroligneous acid from carbonization of wood; tannin liquors from extraction of wood; distillates in furfural production from wood and agricultural wastes; fusion residues of caustic soda treatment of wood *(17)* for oxalic acid production; and acetate and formates from black liquors from wood pulping.

Synthetic sources

For over 30 years acetic acid has been produced synthetically from alcohol by pyrochemical oxidation, and from acetylene *(6,16)* and other hydrocarbons. The product is almost anhydrous, but contains impurities which may be removed easier and cheaper than the impurities in the more dilute acid from natural sources.

Spent recycle solutions

Acetic acid occurs in spent or recycle solutions from the processing of other chemicals. Acetylations may use strong acetic acid, the water formed being distilled off to cause the process to go to completion, as in esterification. Strong acetic acid is also an excellent solvent for many reactants. The principle that some products precipitate with addition of water is applied to simplify some organic syntheses in liquid separations. Thus acetic acid has been used to extract aromatic hydrocarbons from aliphatics. By successive slight dilutions, the selectivity may be changed to separate several different consecutive fractions from the original mixtures.

First used in separating acetic acid and water—Now used in separating many other liquid mixtures.

1. **Azeotropic distillation** for complete separation of two close boiling liquids in one column. An added liquid increases the relative volatility of one—usually the more volatile.
2. **Extractive distillation.** An added liquid decreases the relative volatility of one component—usually the less volatile.
3. **Liquid-liquid countercurrent extraction.** An added liquid washes one liquid out of the mixture.
4. **Extracting equipment.** First designed for concentrating acetic acid, has since been modified for use in other industries.

The largest industrial use of acetic acid is in cellulose acetate manufacture. In the process, the acetate is esterified in anhydrous acetic acid, is precipitated by adding dilute acid to give a strength of 30%; and is then removed from the "flake" produced. Millions of pounds of glacial-grade acid are then recovered for reuse per day in a single plant.

Waste liquors

Separation of acetic acid from impurities in waste process liquors is often uneconomic. Thus, the Fischer-Tropsch process produces hydrocarbons, alcohols, and ketones, which are separated from a residue of acetic and butyric acids in 30 to 100 times as much water. Since the biological oxygen demand (BOD) of these acids, or their salts is a menace to fish and other aquatic life, they cannot be passed as waste in a stream and may have to be recovered. Equally troublesome are the black liquors from wood delignification. The profitable recovery of acetic acid from these liquors is an interesting application of chemical engineering techniques.

Separation of water and acetic acid

Two liquids in solution are usually separated by distillation, the mechanism depending on the difference in their boiling points or (more correctly) their relative volatilities. It is theoretically possible to turn out substantially acid-free water at the top of a rectifying column, and glacial acid at the bottom; and calculations show that the column would not have to be of prohibitive height if modern, efficient plates are used. However, the reflux ratio would give an excessive heat cost and column diameter. The distillation difficulty is illustrated by the closeness of the vapor composition curve, particularly in the dilute range (Figure 1).

During the past forty years numerous special distillation methods have been patented for recovering acetic acid from many different solutions. Three of the modern unit operations used for separating industrial liquors have had much of their development in recovery of acetic acid from spent processing liquors (8). Their descriptions follow.

Azeotropic distillation

A modification of a steam distillation technique used by Sidney Young sixty years ago for separating absolute alcohol from water is used in numerous installations to separate acetic acid from water. Since the vapor pressure of a mixture of two *immiscible* liquids is equal to the sum of the vapor pressures of the individual pure liquids, the boiling point of the mixture will be considerably lower than that of either of the liquids alone. Hence, if a liquid which is completely miscible with anhydrous acetic acid but substantially insoluble in water is added to aqueous acetic acid, and the mixture is distilled, the water and other liquid will distill together at a lower temperature as an azeotropic mixture while the boiling temperature of the acetic acid will not be affected nearly as much. A rectifying column can thus separate the azeotropic mixture of water and the entraining liquid from the acetic acid much more readily than it could separate the water alone *(1, 9, 11, 14)*. Mixed vapors from the top of the column can be condensed in a single condenser; the condensate separated into two liquid layers in a gravity decanter; the "sweet water" discharged substantially acid-free; and the entrainer returned as reflux to remove more "sweet water," while the dry acid passes from the bottom of the column.

The principal cost of distillation is the heat in vaporizing the product and the reflux. The heat of vaporizing the overhead product (water) is almost fixed; thus, the variable is the amount of heat for vaporizing the entrainer which is returned as reflux; and reflux ratio is always of prime importance. Excluding the liquid solubilities, *all* of the entrainer and *none* of the water are usually refluxed in an azeotropic distillation; and the reflux ratio is that of the azeotropic mixture—pounds of entrainer per pound of water. Entrainers with lower vapor pressures (higher boiling points) have lower amounts in their azeotropic mixtures and hence lower reflux ratios and washing efficiency in the column.

If the entrainer is chosen to have an extractive ability for acetic acid, then it will wash the acid out of the vapors approaching the top of the column somewhat in the method of the extractive distillation discussed below, and allow substantially acid-free vapors to pass overhead.

Thus, a higher boiling entrainer may be selected if it has a good extractive coefficient for acetic acid, such that the smaller reflux will suffice to hold the acid down from the top.

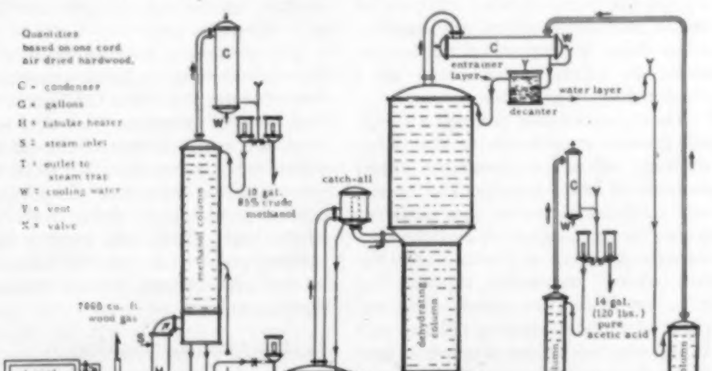

Figure 2. Flow sheet of production of acetic acid from pyroligneous acid.

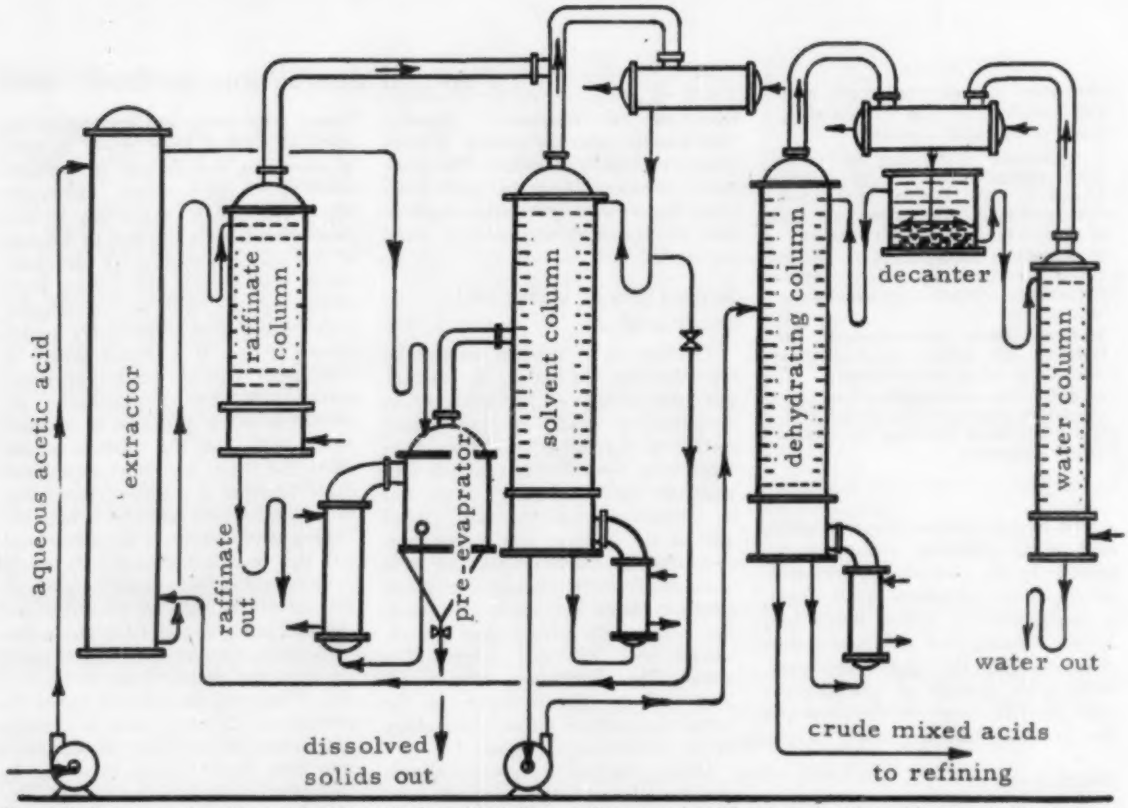

Figure 4. Recovery of acetic and formic acids from black liquo rs from wood pulping by extraction with a low boiling solvent.

Acetic acid *continued*

With entrainers of higher boiling points, operation losses are due less to lower vapor pressures and smaller amounts distilled per pound of water. Sweet water may be removed containing as little as one part acid in ten thousand parts of water.

It is at least as difficult, however, to rectify acetic acid from high boiling entrainers as it is to rectify water itself from acetic acid, due to the closeness of vapor and liquid compositions, as shown in Figure (1). A method has been developed *(10, 14)* to prevent this necessity in the column by removing the last of the entrainer with some of the water present.

The azeotropic operation has been modified somewhat for use with many different sources of dilute acetic acid (from pyroligneous acid, the manufacture of cellulose acetate, Hexogen, aspirin, and other materials), and the total productive capacity has been as high as thousands of tons per day of anhydrous acid.

Wood distillation liquors

Azeotropic distillation for the recovery of pyroligneous liquors is advantageous because of simplicity and relative cheapness of the equipment required, particularly for smaller installations. It has been so used in various countries.

Figure 2 is a flow sheet *(9, 11)* for a wood distillation plant, Retorts, storage for pyroligneous liquor, and the methanol-removing column are on the left. The demethanolized liquor discharged from the base of the methanol column is passed to the preevaporator, which is especially designed for tarry liquors. Vapors of acetic acid and water are distilled away from tar or other nonvolatile materials which are removed as a residue from the bottom.

These vapors pass through a catchall, or mist evaporator, to the dehydrating column containing a fixed amount of butyl acetate. The vaporous mixture of water and entrainer passes to the condenser; and the condensate flows to a decanter for the two, almost immiscible, liquids. The entrainer layer is returned to the top plate of the dehydrating column and brings over additional amounts of substantially acid-free water in this steam distillation, repeatedly, with practically no loss. The loss in some systems has been less than one pound of entrainer per ton of acid recovered. The entrainer, as the reflux liquid, also washes acetic acid out of the vapors. A small amount of entrainer is dissolved in the water layer; and to recover it, the water layer is passed into the water column. This is fed at the base with live steam, which azeotropically distills out the small amount of entrainer. These vapors go back to the condenser to be condensed with the main body of the vaporous mixture of water and entrainer. Substantially pure "distilled" water discharges from the base of the water column, containing as little as 0.01 to 0.1% acetic acid.

The acetic acid reaches the base of the dehydrating column practically free of water (less than 0.5%) and entirely free of entrainer. This acid may contain a small amount of the tar oils which were steam distilled from the preevaporator into the dehydrating column and came down with the acetic acid. These oils have a high boiling point and can be removed in the acid column by an ordinary distillation.

Extractive distillation

The countercurrent washing of mixed vapors in a distillation column by a descending stream of a high boiling liquid which is a preferential solvent for one of the components, was developed first by Suida in Austria *(17)*, for the removal of acetic acid from pyroligneous acid. In this procedure wood tar-oils are passed

down the distilling column to decrease the relative volatility, or "hold back" the acetic acid from an ascending vaporous mixture with water. The acetic acid leaves the column base dissolved in the high boiling solvent. It is distilled therefrom in a second vacuum still. The acid-free solvent passes back to the top of the first column for reuse as the wash liquid in the extractive distillation. The process produces an acid of 80-90% strength in somewhat more expensive equipment and with the use of a greater amount of steam than employed by other methods.

Liquid-liquid extraction

Theodor Goering obtained a German patent *(4)* seventy-five years ago on the production of concentrated acetic acid from dilute aqueous solutions by means of extraction. Indeed, his method of distilling the extracting solvent with water away from dilute acetic acid shows that he also accomplished so-called "azeotropic" distillation many years before Young dehydrated alcohol by distillation in the presence of a third liquid.

The patent specification helps in understanding the extraction of one liquid from a solution of two or more by a solvent liquid. In Goering's words: "Acetic acid is for a time, mechanically transmitted to another liquid from which it can be separated easily. If water containing acetic acid is brought into contact with ethyl acetate, there will be a division of the acid present between the two liquids. If an entire separation of acetic acid is required from the initial solution, the contact is conducted by a counterflow arranged within the extractor between the two liquid layers. Thus, the concentration of acid in the extraction solvent which is obtained will correspond to the original concentration of the aqueous solution of acetic acid; and a smaller amount of the solvent will be necessary. The original solution is exhausted of acetic acid, while dissolving a certain quantity of solvent, which will later be recovered by distillation. In the production of a concentrated acetic acid, low boiling esters may be employed as solvents. In the distillation which follows, these are removed with moderate dephlegmation, nearly free of acetic acid, while the acid stays behind."

Most of the water need not be distilled in an extraction process, a basic advantage over any distillation method because of the high latent heat of the water. Extraction has by now become an important unit operation of chemical engineering, the mechanics of which have not yet been as well investigated as have those of some other unit operations. This unit operation and much of its equipment are now used in many other industries for separating many other pairs of liquids.

Performance is based on different physical factors from those governing rectifying columns; but calculations are similar, since both are based on diffusional relationships of countercurrently flowing fluid streams. A considerable field of theoretical and practical interest has been opened by the increasing use of extractors, not only for acetic acid concentration, but also for many other separations.

Extraction depends upon a diffusional process between the surfaces of two liquid phases, just as rectification depends on a diffusional process at the interface of a gaseous and a liquid phase. In both cases, mechanical energy causes the intimate contact of the drops, bubbles, or films of the two phases. Then the two respective phases are allowed to separate, after which, the process is repeated again and again.

Combined processes for acetic acid recovery

The liquid streams discharging from extractions or extractive distillations must always be separated by additional distillation steps, at least one of which is often azeotropic. One typical process *(15)* fully using the advantage of these several methods in reducing the heat costs of concentrating acetic acid is shown in Figure 3. In extractor 10, the acid is separated from the water by a selective solvent. The same solvent distills the water overhead by increasing its relative volatility in a first azeotropic distillation, in column 30. The solvent has so high a boiling point that its ratio in the azeotropic mixture is too low to give sufficient reflux to prevent a small amount of the acid from coming over in the "sweet water." To exhaust this of acid, it is returned to extractor 10, at a point where the acid strength is the same. The dry acid-solvent mixture discharges from column 30 to column 40 through pipe 34 where a second azeotropic distillation separates acetic acid from the high boiling solvent. Here the relative volatility of the acetic acid is increased with respect to that of the solvent by a second added liquid which has much less solubility for acetic acid than for the solvent. A final exhaustion by azeotropic distillation in column 50 separates the second added liquid dissolved in the acid layer of the decanter 43; and a final exhaustion in column 20 separates the solvent dissolved in the water first discharged from extractor 10. The solvent so obtained from decanter 23 is added to that from the base of column 40 for recycle to the extractor 10. All four distilling operations are azeotropic in nature.

Wood-pulping liquors

Much more formic and acetic acids are wasted continuously in the black liquors of the Kraft, soda, and neutral sulfite processes than the total amounts which are now used in the world's chemical industry. Some plants evaporate the liquors and burn the concentrates in furnaces to recover the inorganic values as ash; but the acetic and formic acids give only a negligible heat value. Many other plants pass these liquors directly to pollute inland streams. One pulp mill may pollute a stream *(12, 18)* as much as the sewage from a city of half a million people, and one half of this pollution is due to these acids. Their salts have the same effect.

It has recently been shown *(12)* that about one fifth of the total acetic acid needs of the United States can be readily produced by known techniques from black liquors, by one of the smaller, but most rapidly growing processes of the pulping industry, i.e., the neutral sulfite semichemical (NSSC). Waxes are present *(2)* and pentoses, from which a large part of furfural needs of the chemical industry could be produced by methods used with other liquors *(5)*. An even greater amount of the acids is present in the liquors from Kraft pulping; and a large fraction of this amount may also be recovered immediately. The acids present as sodium salts might be regarded as of zero value (actually a negative value) because the nuisance characteristics of the materials make a cost in disposal.

In neutral or alkaline chemical liquor pulping, the total amount of formic and acetic acids has been analyzed in the black liquors from many plants to be between 4 to 10% of the weight of pulp produced, or possibly 2 to 6% of the dry weight of the wood used. This is a stupendous total from the many millions of tons of wood pulped, when one considers the positive value to industry if the wood is recovered and when the nuisance is discharged to streams. Acetic acid selling at $200/ton, and formic acid at $320/ton, have a considerable potential revenue per ton of pulp produced of $10.00 to $15.00 or

Acetic acid
continued

more. In a usual recovery plant, this recovery operation will cost, including amortization of the plant, less than one half of the values of the acids recovered. An even more profitable operation results if furfural is made of the pentoses present and recovered as an integral part of the processing.

The black liquors from the pulp washes would first be concentrated in usual multiple-effect evaporators to 40-50% of total solids, and then acidified with sulfuric acid to release the acetic and formic acids, totaling 10 to 15% of the resulting solution.

The three-unit operations: azeotropic distillation, extractive distillation, and extraction have been sharpened to recover these acids from the black liquors. They are blunted somewhat by the large amount of impurities, but these are not as troublesome as the lesser amount of impurities in liquors from wood carbonization. The larger amount of formic acid in these liquors also increases the corrosive effect on equipment. A further major problem is the emulsification which may occur during extraction between most solvents and the concentrated black liquors. Success depends on the proper selection of the solvent of the extracting equipment, and of the process design.

The accompanying flow sheet indicates a possible extraction process, starting with the acidified liquor. The final separation by standard methods of the formic acid and acetic acid may be the same in each case.

The solvent, as always, should be chosen to have a maximum solubility for acetic acid. It should normally have a minimum solubility for water, to minimize the amount of water to be distilled and also so that any azeotropic mixture which it may have with water, would be such as to separate into two layers one of which is almost pure water. Another requirement, which greatly restricts the choice, is that it must not form emulsions. The solvent must have a boiling point sufficiently higher or lower than acetic acid so that separation is readily possible by distillation. Processes using both high boiling and low boiling solvents have been patented.

Use of Low-Boiling Solvent. In Figure 4 a low-boiling solvent for acid recovery allows the extraction of substantially all of the acid in an extract or solvent layer, from which the solvent is distilled for reuse.

The acetic acid is removed in the extractor, from the acidified liquors by the selected low-boiling solvent. The extract layer with all of acids and some water passes to a preevaporator wherein extracted solids are left behind with vapors going to a solvent column. This separates solvent overhead for return to the extractor. The residue or raffinate liquor from the bottom of the extractor passes to a raffinate column for recovery of the solvent dissolved therein. Vapors pass to the same condenser as those from the solvent column. The solvent-free raffinate may then pass to further standard processing to recover the sodium sulfate contained therein.

The water and acid mixture are discharged from the base heater of the solvent column and passed to a dehydrating column where the water is azeotropically distilled overhead, using a suitable azeotropic withdrawing agent. Water is stripped of dissolved entraining liquid in the water column. The dry mixture of acetic acid and formic acid from the base of the dehydrating column is passed to a crude acid storage tank, from which it goes to a standard refining distillation which separates pure acetic acid and pure formic acid for sale.

Recovery of chemicals from pulping liquors

O'Donoghue has well described processes *(7)* for recovery of sulfur and soda from waste NSSC liquors. The NSSC pulp producer, like others, has been happy to recover inorganic chemicals in expensive plants. Usually after evaporation of liquors the residual organic material is burned to give sodium sulfide and soda ash with losses of carbon dioxide and sulfur dioxide. The Kraft industry reuses the sodium sulfide; but the NSSC process requires the sulfite. Feder *(3)* oxidized the sodium sulfide of the smelt back to sodium sulfite for reuse in NSSC processing.

The recovery of formic and acetic acids may be accomplished as described above as an additional step of any of these processes of recovery of soda and/or sulfur.

Presented at a plenary lecture at the 1958 Congress of European Chemical Engineers, ACHEMA, Frankfort am Main, June 6, 1958.

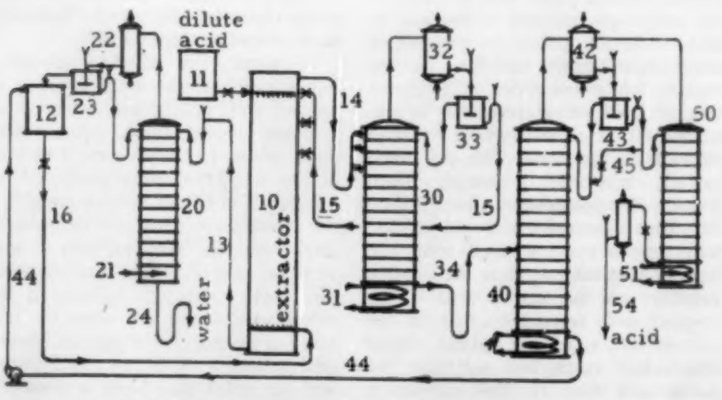

Figure 3. Combination of one extraction step and four azeotropic distillation steps for recovering acetic acid with a minimum of heat costs.

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Automation of filtration equipment

Automatic control of filtration equipment can pay for itself, in many cases, if the process engineer studies the design of the filter chamber, considers the operation of elements themselves and the cleaning and cake-discharge features of the filter. Considerable savings can be effected in lost time, labor, and the improper handling of the operation, if the objective is always the right filter for the right job.

JAMES F. ZIEVERS and CLAY W. RILEY, *Industrial Filter & Pump Mfg. Co., Chicago, Illinois*

This discussion on automation is limited to cyclical-type-pressure filtration equipment such as leaf filters or tube filters. Generally the subject is divided into two parts: (1) the engineering aspects of the problem and, (2) the economic aspects of the problem. Since there are five engineering phases to the problem of applying automation to a filtration station, naturally there is a certain degree of overlap between these phases.

Engineering considerations

The first phase involves the selection of the proper operating sequence, the choice of which must be compatible with the process. For example, if the process calls for a filter-cake leaching step, the automatic sequence must provide for it; if, on the other hand, the process calls for the discharge of a dry cake, similarly the automatic sequence must provide for it.

In addition to being fitted for the process, the operating sequence must be fitted to the plant. Here again the type of cake discharge, the type of power called for on controls (pneumatic or electric), the actual physical location of the filter station (relationship to pumps, drainage, etc.) must be taken into account. A sample work form, Figure 1, is included here as an aid in a study of an automatic filter station. The form is filled in by starting through the sequence of filter-station operations which is consistent with the process and with the plant. As controls are needed in the station, they can be marked on the filter outline and also in the table provided. The comment column provides space for a note on the control equipment to be used, its cost, etc.

After the work sheet has been roughed in, further consideration of the process sequence may induce a decision to add or subtract steps from the operating sequence. For example, the process covered by Figure 1 calls for a blowdown of the filter cake and for subsequent leaching. This means that pressure across the filter cake must be maintained at all times to avoid cracking. For this reason step number 4, a short step—prepare to blow, was introduced. The next phase of the problem calls for choosing the operating limits and safety features desired.

Practically speaking, in cyclical filtration, either of two general contingencies may limit the cycle: (1) solids build-up, which is a function of the concentration of solids and the rate of flow and hence a function of time since both solids and rate of flow as given are assumed and, (2) pressure build-up (or better stated) pressure drop across the cake. A safe and efficient automatic system should respond to both. A timer may be used for operating limits based on ultimate cake capacity, and a pressure switch to cut out the timer in case of premature pressure build-up. Whichever control is actuated first moves the control system on to the next step in the sequence. The previous statements were based on the assumption that the station would be operating with centrifugal pumps; however, the station may be operating with positive displacements pumps, in which case the excess pressure loss across the cake can be telemetered to the control system by the flow recorder if such is used, or by a minimum reading pressure switch on the effluent side of the filter.

For some reason or other, the filter station may pass solids. This situation can be handled in a number of ways. Photoelectric detectors can tell of an increase in turbidity and then can shut down the pump, valves, or the whole system as desired; or a pressure switch on a trap filter can communicate a "bleed thru" at the main filter battery to the operator by means of an alarm and he can shut the system down manually; or the pressure switch can be wired directly to the conrtol system and the filter station can be shut down automatically. In cases where clarity of effluent is of extreme importance it is believed that a pressure switch signal from a trap filter is a more efficient safety device than a signal generated by a photoelectric turbidity detector. This is due first to the fact that the trap filter, besides shutting the system down, absolutely stops the flow of contaminating solids, and second, because with this system more filters are sold.

Timers. Timers governing various steps in the operating sequence, should be chosen so that their maximum duration is slightly greater than the time it is expected will be required. If timers with too long a duration are used, accuracy of adjustment of the automatic control system is lost.

Alarms. Alarms can be visual, audio, or both. If the process calls for an alarm, both types should be used. Make the audio alarm loud and the visual alarm bright. It may be desirable to have alarms sound not only in the filtration station but also, for example, in the superintendent's office. This is a simple thing to accomplish and it is relatively inexpensive. As pointed out before, alarms can, and should be, coupled wfth

trap and safety systems. Safety switches must be built into the system so that it can be shut down at once. Knowledge of the process and of the plant will enable the designer to decide what must happen to the setup in any emergency, and controls should be so set. Normally closed valves are to be preferred, because in the event of a power failure, the system is isolated.

From decisions based on the considerations pointed out, equipment best fitted to accomplish what it is supposed to do must now be chosen. First, timers must be selected for each phase of the operating sequence. Clock-type timers are more expensive but more flexible than cam or other types. In most cases, the filtration phase of a process is not a cut-and-dried affair. A slight process change or product change alters the filtration times, cleaning time, etc. Therefore, flexibility is needed. The control system will of necessity include a number of relays. Standard-type relays (opposed to the long-wear types) are sufficient in this case. In any filtration station there are relatively few operations per unit of time.

To conform with JIC standards, the system should be wired with three different colors of numbered wire. Experience indicates that the control box should be designed with timers and adjustable controls inside the cover with an emergency switch placed outside. The box must be dust-tight and waterproof. The delicacy of the operation determines whether the designer may wish to include a lock on the outside of the cover. Location of the control box, whether in the station or at some remote point, is a matter to be decided upon in each individual plant and process.

Auxiliary equipment

Auxiliary equipment must also be chosen. The process determines whether the inclusion of temperature recorders, pressure recorders, flow recorders, and flow controllers are desired. Power valves may be opened or closed. Generally the use of normally closed valves is to be preferred because, if there is a power failure, the station will then be isolated; however, it may be desirable for a certain valve (the drain, for instance) to be open in emergency. In this case a normally open valve would be used.

Where continuous venting is required, use of a steam-trap sort of device is suggested. The size of the vent control is affected by the operating sequence, and in turn affects other controls. For example, if the sequence calls for a cake blowdown, the vent must be sized so that it will not allow air to escape as fast as it is introduced during the blowdown and, in this case, it will be so small that it will probably not vent the chamber fast enough during "fill." Hence the automatic sequence must provide for the inclusion of a power-operated air-escape valve which is to be opened during those phases of the filter sequence when the chamber is being rapidly filled with liquid.

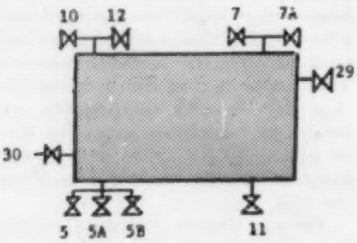
When flow rate and type of solids are such that there is a possibility of settling or of improper cake distribution, often the desire is to recycle a certain percent of the total flow and thereby to pull the solids into an even cake. In the past this has been done by running a recycle line back to the feed tank. One may, however, build a "recycler" into the filter by the use of proper educator and piping.* Control valve in the recycler line may be manual or, if it is to be a power-operated valve a butterfly type is suggested.

Automation and Flexibility

The next phase of the problem is that of creating flexibility in the automatic system. Experience has shown that it is a good idea to provide a semiautomatic sequence at least for the break-in period for operating personnel. This can be done at little cost and is quite effective. A toggle switch is wired across the timers in such a way that the timers still act as relays but not as timers. Closing the toggle switch places the system on *semiautomatic*. When on *semiautomatic*, additional toggle switches are used to activate a control combination for a particular stage in the filtration sequence, or they may be used to activate individual controls. Systems have been built both ways, and in this company it is thought that individual valve control is a more flexible arrangement.

When more than one filter is to be

* *Patent pending.*



CONTROL NO.	DESCRIPTION
5	Main inlet
5A	Precoat inlet
5B	Leach inlet
7	Main discharge
7A	Precoat discharge
10	Air inlet
11	Drain
12	Air relief
29	Leaf vibrator
30	Sluice inlet

Figure 1. In "automating" filtration equipment the design of the indicating panel (shown above) or the operations chart (below) is the final phase of the engineering problem.

NO.	OPERATION	APPROX. DURATION	5	5A	5B	7	7A	10	11	12	29	30	COMMENTS
1	Fill for precoat	5 min.		X						X			Timer
2	Precoat	10 min.		X			X			X			Timer
3	Run	12 hrs.	X			X							Press. Sw. & Ti. Cont.
4	Prepare to blow down	10 sec.	X			X		X					Delay clos. valve 5
5	Blow down	2 min.				X		X					Timer
6	Fill for leach	5 min.			X					X			Timer
7	Leach	10 min.			X	X							Timer
8	Prepare to blow down	10 sec.			X	X		X					Delay clos. valve 5B
9	Blow down	2 min.				X		X					Timer
10	Fill for shake	5 min.								X		X	Timer
11	Shake	1 min.									X		Timer
12	Drain	2 min.							X		X		Timer
13	Sluice	2 min.							X			X	Timer

All valves normally closed except ____.
"X" indicates control actuated, and valve open.

. . . the last phase of the engineering problem involves the design of the indicating panel. It may be located in the filter station, or at some remote spot.

automated, considerable savings in controls cost may be effected by using one control system equipped with a reset provision. For example, on one particular system involving twenty-six filters, it was decided to group them in sixes. Cost for automatic controls, excluding power-operated valves, for one filter was about $1,200. The same cost for six filters with the reset system was about $1,700.

Whatever operating sequence is decided upon and however the filters are grouped together for control, to insure a rapid understanding of the system and hence a more efficient operation and maintenance, all controls should be clearly indicated on a chart in a readily visible spot. One convenient method for accomplishing this is to set up the operations chart in the same form as the work sheet shown in Figure 1. The valves themselves can be numbered. Care should be taken to use the same number for every valve that performs the same function. Where several units are grouped together for control, a prefix may be used to designate a particular filter; for example, if number 11 is used to designate the filter drain control, number 411 could be used to designate the drain control on filter number 4 in a multiple-control system. The operational chart should also contain emergency instructions.

Design

The last phase of the engineering problem involves the design of the indicating panel. It may be located in the filter station or at some remote spot such as the superintendent's office. It may be designed in the form of the operational chart or work sheet shown in Figure 1 or it may be designed as a filter outline. In the last-mentioned case, indicating lights are located in the approximate position of the controls on the actual filter. The panel may show individual controls or merely a position in the operational sequence or both. If desired, flow and/or pressure recorders may be incorporated in the panel. Where filters are grouped together, it is suggested that separate indicating panels be used for each filter. If piping in the filter station is painted in some functional color code, it may be desirable to use a corresponding color code in the lights on the indicating panel.

Economic considerations

Costs of the components in an automatic control system are based on the recommendations made under the discussion of engineering aspects. This figure depends upon the number of steps in the operational sequence. Automatic control (exclusive of power-operated valves but including solenoid actuators) for a single filter range in cost from $700 to $1,900. As pointed out previously, when filters are grouped for control, cost of control per unit is dropped considerably. An estimate of $200 is probably safe for the cost of each additional filter over the base price in a group control system. These figures include housing in approved cabinets.

Power-operated cast-iron valves range in price from $107.45 for a 1-in. diaphragm type with a pneumatic actuator to $452.70 for a 6-in. diaphragm type with the same actuator. Stainless steel valves range from $140 to $808.40 for the same sizes and types. Equivalent figures for rubber-lined valves are $132.35 and $585.90 respectively. Flow recorders are priced at about $535. These same recorders may be combined as recorder-controllers and are priced at about $585. Pressure switches run about $30.00.

A question often asked is whether automation will pay for itself. It will, at least in many cases—in those cases where engineering considerations of process and plant indicate automation is feasible. Against the cost of automation must be balanced the savings resulting from the elimination of lost time. With a flexible control system of the type described above, the filter station may be "tuned" to the process so that downtime is cut to a minimum. This may mean more cycles per day per filter and hence the possibility of using either smaller or fewer filters. In either case, a potential saving is effected.

A well-designed control system should eliminate all labor from the station except possibly one maintenance or supervisory man. This is important not only because of the cost of labor but also because of the difficulty of obtaining it. Also one must remember that those controls report for work on time and in shape every day of the week if necessary, and work overtime willingly. They also prevent improper handling of the process and costly errors. Proper control of the process in the filter station should cut maintenance cost on the filters.

Filter and process engineer

Comment has been made about the process in the plant being suited to automation. The filters must also be suited to automation. "Pretty well" designed units are not good enough. The automatic station will be only as good as the filter regardless of how good the controls are. This means that the process engineer will have to be extremely careful to choose the right filter for the right job.

First, he should consider especially the design of the filter chamber. This should allow for good distribution of the incoming fluid and for good drainage of sluiced cakes and/or heels. There should be no spots inside the chamber for the hang-up or the build-up of solids. Construction must be sturdy, of the proper materials, and should provide for a quick and easy maintenance, such as the replacement of filter elements and things of that type to cut downtime to a minimum when that is necessary.

Second, the process engineer should consider the elements themselves. They should provide for a minimum of head loss and a clean getaway of the filtrate. They should be unsusceptible to blinding. They should be properly spaced and they should be of sufficient strength to ensure long life and low maintenance.

Third, the process engineer should consider the cleaning and cake-discharge features of the filter. Some techniques used today to clean pressure-type filters include: sluicing, which is a satisfactory technique for a wet-cake discharge; hydraulic shock, commonly used on tubular-type filters and also satisfactory for wet-cake discharge; vibration of the filter element, which has been found satisfactory for both wet-and dry-cake discharge; power shaking of the filter bags or sleeves, which is also suitable for wet- or dry-cake discharge; and the introduction of air turbulence to the filter chamber, which is satisfactory for wet-cake discharge. One of these or some combination of them will probably be the most feasible method of cleaning a filter in any given process. In each case, great care must be taken in choosing the method of cleaning to be used and in each case the method chosen must be positive, quick, and must lend itself to automatic control.

Presented at A.I.Ch.E. meeting in Boston, Mass.

Effects of drying conditions on the properties of spray-dried particles

The relationship of size and density of spray-dried particles to the initial size of the spray drops was investigated, using the operating variables, air temperature, and feed concentration, as parameters.

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An investigation was undertaken to relate the size and density of spray-dried particles to the initial spray drop size, with the operating variables as parameters. The three materials dried were sodium sulfate, coffee extract, and a clay slip, which in liquid-feed form represented a true solution, a colloidal suspension, and a fine slurry or suspension, respectively. The drying was performed for various air temperatures, feed temperatures, and feed concentrations, these variables being the ones most susceptible to change in any spray dryer. The dry particles obtained were classed as crystalline, amorphous, fine agglomerates.

General Theoretical considerations

Although the drying of droplets containing solids in solution or suspension is controlled by the rates of heat and mass transfer, these processes are made complicated by variations in the total drying system. For example, heat transfer is strongly dependent upon temperature differences and, in a spray dryer the temperature distribution in the drying gases is difficult to predict due to the combination of the effects of evaporative load, heat losses to the surroundings and complex air-flow patterns. The relative velocities between the evaporating droplets and the gases are important but are also variable and difficult to predict.

Mass transfer from the surfaces of the droplets to the main body of the drying gases is likewise subject to the same variations of air flow patterns and velocities relative to the particles. Furthermore, mass transfer from the interiors of the droplets to their surfaces is also complex and is markedly affected by temperature level, heat-transfer rates, and the type of material being dried.

To complicate further the picture, in a spray of wide droplet size distribution, rates of drying vary with particle size so that small sizes dry faster and have more opportunity to become overdried or overheated.

Drying cycle of a droplet

A droplet may enter a spray-drying chamber at a feed temperature above, below, or equal to some dynamic-equilibrium tempertaure of the drying air. In the case of pure water drops, this temperature would be the wet-bulb temperature. The dynamic-equilibrium temperature will be higher than the wet-bulb temperature for droplets of solution *(6)*. In the case of suspensions, the dynamic-equilibrium temperature may be equal to the wet-bulb temperature *(2)*. If the initial drop temperature is not equal to the dynamic-equilibrium temperature of the drying air, it will endeavor to approach that temperature. During this initial unsteady-state period the amount of drying taking place is usually negligible although this may not always be true at very high temperatures *(3)*.

If the droplet establishes a dynamic-equilibrium temperature with the drying air, it exhibits a constant-rate drying period *(2, 6)*. Length of the constant-rate period will depend upon the temperature driving-force and the internal mass-transfer mechanism. The higher the drying temperature of the air and the higher the feed concentration, the shorter will be the

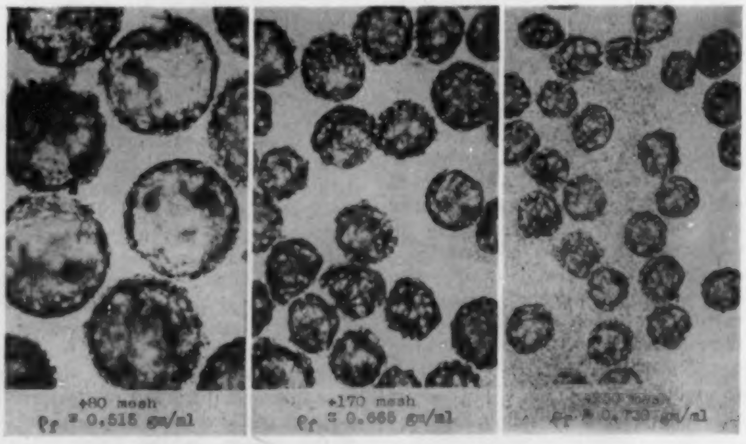

Figure 1. Spray-dried sodium sulfate showing the variation of effective wall thickness with particle size.

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constant-rate period. It is entirely possible that it may be negligible at high temperatures and high solids contents.

The falling-rate period may be considered as divided into two stages. The first is the formation of a rigid or semirigid structure on the surface of the particle; the second is the removal of the remaining portion of the moisture present and this is frequently accompanied by internal vaporization which may cause particle expansion. It is quite probable that in the drying of some materials these two stages occur simultaneously. This has been observed in movies of the drying of single drops *(5)*. The first stage of the falling-rate period is characterized by the formation of a solid surface which may be almost entirely, partially, or negligibly pervious to the flow of moisture. Then, the drop temperature rises and causes the internal stresses in the particle due to vapor formation. These are relieved either by the greater mass-transfer driving-force, by expansion of the surface, and/or by rupture of the surface.

The degree of dryness attained by the particle during the falling-rate period depends upon the length of time it is exposed to the drying gas, the final temperature and humidity of the gas, and the particle size.

Prediction of particle properties

For inorganic salt solutions, Charlesworth and Marshall *(2)* developed a semitheoretical equation to predict the minimum time necessary to form a solid crust and thereby fix the final particle diameter. By substitution of suitable expressions for the evaporation time in terms of the particle diameter into their equation, the following relation for the ratio of the final to the initial drop diameter was obtained:

$$\frac{x_f}{x_0} = \left[1 - 1.84\frac{\frac{\epsilon}{4D_l}\ln\left(\frac{\rho_s C_s}{\rho_0 C_0}\right)}{\phi^2 + \frac{\epsilon}{4D_l}\ln\left(\frac{\rho_s C_s}{\rho_0 C_0}\right)}\right]^{1/3} \qquad (1)$$

where,

ϕ is the positive root of

$$\tanh \phi = \frac{\phi}{\frac{\epsilon}{8D_l} + 1} \qquad (2)$$

for large values of $\frac{\epsilon}{8D_l} > 0$,

$$\phi = \frac{\epsilon}{8D_l} + 1 \qquad (3)$$

and ϵ, for the case of no relative velocity is given by

$$\epsilon = \frac{8k_f \Delta t_m}{\lambda \rho_l} \qquad (4)$$

From Equation (1) it would appear, at first, that the final particle diameter is directly proportional to the initial drop diameter. However, closer inspection of the terms in brackets will show that they vary with the operating variables and the initial drop diameter.

From a material balance on the solids content of an evaporating drop,

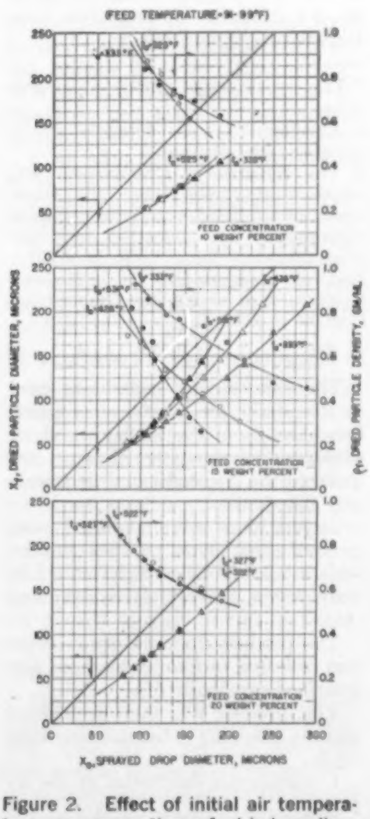

Figure 2. Effect of initial air temperature on properties of dried sodium sulfate drops (feed temperature=91-99° F.).

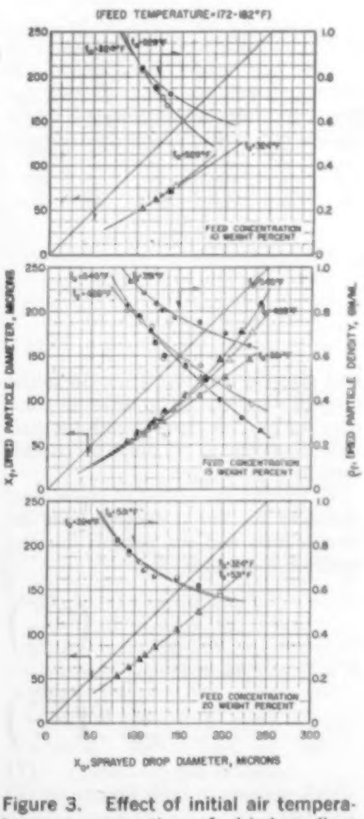

Figure 3. Effect of initial air temperature on properties of dried sodium sulfate drops (feed temperature=172-182° F.).

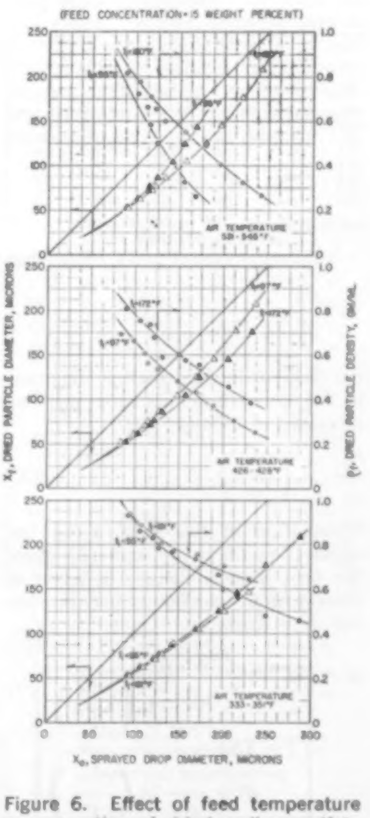

Figure 6. Effect of feed temperature on properties of dried sodium sulfate drops (feed concentration=15 wt. %).

Table 2.—Operating Summary, Material Handled: Sodium Sulfate

	Drying Air					Feed Properties						Atomization		Product	
	Temperature, Inlet		Temperature, Outlet										Calculated Spray Parameters		
Run Number	Dry Bulb, °F	Wet Bulb, °F	Dry Bulb, °F	Calculated Wet Bulb, °F	Mass Flow Rate, lbs/hr	Concentration, weight % solids	Rate, lbs/hr	Temperature, °F	Viscosity, cp	Density, gm/ml	Surface Tension, dynes/cm	Nozzle Pressure, lbs/sq in.	Mass Median Diameter, microns	Bulk Density, gm/ml	Mass Median Diameter, microns
S-1	331	132	248	114	144.5	.15	4.51	95	1.37	1.133	76.7	120	109	0.374	67
S-2	426	121	248	112	168.5	15	4.18	97	1.33	1.133	76.5	120	135	0.315	91
S-3	333	111	252	106	288	15	3.48	95	1.37	1.133	76.7	120-240	165	0.465	101
S-4	428	118	239	109	162.9	15	4.51	172	0.57	1.109	60.6	115-185	142	0.412	88
S-5	545	129	252	112	141.3	15	4.50	180	0.54	1.107	58.4	100-140	151	0.365	98
S-6	351	113	252	108	259.5	15	4.41	181	0.53	1.106	57.9	90-140	158	0.501	94
S-7	522	128	241	113	148.8	20	4.90	99	1.60	1.183	79.6	70	123	0.379	83
S-8	531	128	248	112	153.5	20	4.83	172	0.69	1.158	64.6	90	106	0.452	69
S-9	327	108	239	106	272	20	4.84	91	1.76	1.185	80.5	120	112	0.438	74.5
S-10	324	109	239	106	270.5	20	4.83	178	0.67	1.156	63.1	108	122	0.442	83.5
S-11	325	130	243	112	168.4	10	4.53	95	1.07	1.085	72.9	113-120	119	0.467	57.5
S-12	529	127	241	110	159.5	10	4.37	174	0.47	1.062	55.7	135-185	111	0.467	51
S-13	333	109	243	106	318	10	4.45	97	1.04	1.084	72.6	99	131	0.473	64
S-14	324	107	239	100	319	10	4.48	178	0.45	1.060	54.5	180-215	135	0.471	66.5

Note: nozzle orifice diam. = 0.006 in.

Table 4.—Summary of Operating Data, Material Handled: Coffee Extract

	Drying Air					Feed Properties						Atomization		Product		
	Temperature, Inlet		Temperature, Outlet										Calculated Spray Parameters			
Run Number	Dry Bulb, °F	Wet Bulb, °F	Dry Bulb, °F	Calculated Wet Bulb, °F	Mass Flow Rate, lbs/hr	Concentration, weight % solids	Rate, lbs/hr	Temperature, °F	Viscosity, cp	Density, gm/ml	Surface Tension, dynes/cm	Nozzle Pressure, lbs/sq in.	Mass Median Diameter, microns	Bulk Density, gm/ml	Average Moisture Content, lb/lb solid	Mass Median Diameter, microns
Co-1	512	126	222	105	203	22	5.42	145	1.370	1.082	35.8	100	115	0.270	0.0658	98.5
Co-2	518	126	217	106	202.5	13.6	5.14	140	0.945	1.044	42.3	90-95	111	0.264	0.0738	72
Co-3	500	124	212	104	201.5	7	5.04	141	0.670	1.014	41.0	85	136	0.312	0.0769	67.5
Co-4	419	118	221	102	289.5	22	5.42	131	1.555	1.085	36.9	75	119	0.377	0.0864	86
Co-5	414	117	212	103	291	13.6	5.22	140	0.945	1.044	42.3	75-90	121	0.412	0.0896	71
Co-6	417	116	206	100	293	7	3.02	131	0.750	1.017	42.6	85	170	0.402	0.0976	79
Co-7	329	108	208	99	387	22	5.42	133	1.525	1.085	36.7	75-85	131	0.422	0.0906	83.5
Co-8	324	106	208	96	409	13.6	4.89	131	1.025	1.046	43.2	125	114	0.607	0.0868	62
Co-9	329	108	208	98	407	7	4.96	131	0.750	1.017	42.6	115	137	0.553	0.0960	60

Note: orifice diam. (nozzle) = 0.006 in.

Table 5.—Summary of Operating Data, Material Handled: Attapulgus Clay Slip

	Drying Air					Feed			Atomization		Product
	Temperature, Inlet		Temperature, Outlet							Calculated Spray Parameters	
Run Number	Dry Bulb, °F	Wet Bulb, °F	Dry Bulb, °F	Calculated Wet Bulb, °F	Mass Flow Rate, lbs/hr	Rate, lbs/hr	Temperature, °F	Density, gm/ml	Nozzle Pressure, lbs/sq in.	Mass Median Diameter, microns	Product Mass Median Diameter, microns
Cl-1	419	123	226	113	223	7.87	95	1.036	120	160	75
Cl-2	523	128	248	117	204.5	7.57	95	1.036	120	157	73.5
Cl-3	331	108	226	106	423	7.39	95	1.036	120	143	66
Cl-4	331	109	226	105	423	8.13	158	1.021	100	156	70.5
Cl-5	433	120	216	112	220	7.92	167	1.019	100	163	75
Cl-6	549	128	223	117	167	7.85	158	1.021	100	149	67.5

Notes: feed conc., all runs = 6% solids
nozzle orifice diam. = 0.008 in.
bulk density varied from 0.423-0.449 gm/ml.

the ratio of the final particle diameter to the initial drop diameter may be expressed as follows:

$$\frac{x_f}{x_0} = \left(\frac{\rho_0 C_0}{\rho_f C_f}\right)^{1/3} \qquad (5)$$

Elimination of the ratio, x_f/x_0, between Equations (1) and (5) gives the final particle density in terms of the operating conditions and the initial drop diameter.

$$\rho_f = \frac{\rho_0 C_0/C_f}{\left[1 - 1.84\,\dfrac{\dfrac{\epsilon}{4D_l}\ln\left(\dfrac{\rho_s C_s}{\rho_0 C_0}\right)}{\phi^2 + \dfrac{\epsilon}{4D_l}\ln\left(\dfrac{\rho_s C_s}{\rho_0 C_0}\right)}\right]^{3/2}} \qquad (6)$$

This relation predicts the density of that particle resulting from an initial drop of diameter x_0. In order to compare the particle density with the particle diameter, x_f, x_0 must be considered as a parameter.

To predict the effects of the several variables on the particle-droplet diameter-ratio and the particle density, consider the factor

$$F = 1 - 1.84\,\frac{\dfrac{\epsilon}{4D_l}\ln\left(\dfrac{\rho_s C_s}{\rho_0 C_0}\right)}{\phi^2 + \dfrac{\epsilon}{4D_l}\ln\left(\dfrac{\rho_s C_s}{\rho_0 C_0}\right)} \qquad (7)$$

which appears in both Equations (1) and (6).

Table 1 summarizes the effects of certain drying variables on the ratio of the dry particle to initial spray droplet diameter as predicted from Equations (1) and (6).*

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* This summary is restricted as follows:
1. Equations (1) and (6) apply only to inorganic salt solutions.
2. The equation of Charlesworth and Marshall (2), upon which the above equations are based, was developed from experimental data restricted to initial drop diameters from 1,338 to 1,791μ, feed concentrations from 5.3 to 50.0 wt. % solids, and drying air temperatures from 81 to 270° F.

Experimental Procedure

The experimental techniques used in this study are briefly summarized here. Details of the methods and an evaluation of experimental errors are given in the Appendix and in Literature Cited *(3)*.

Liquid feeds were atomized with grooved - core - type pressure nozzles with a narrow cone angle in a 2-ft. diam. tower, 20 ft. high, as described *(4)*.

The product from the spray dryer was collected *in toto* by methods also described previously *(4)*.

This product was then oven dried and the following determinations were made:

1. Particle-size distribution of the dry particles.
2. Bulk density of the dry product.
3. Particle density of narrow size fractions of product.

. . . to present the results of this study adequately, numerous curves of the experimental data have been prepared, are presented here.

4. Photomicrographs of several narrow-size fractions.

Bulk density

Product bulk densities were determined in a specially designed apparatus consisting of a conical feeder, a set of baffles to deagglomerate the aggregates, and special volumetric cups. The conical feeder controlled the rate at which product was fed to the cup. In all measurements a 5-cc. cup was used.

Particle density

Particle diameters were calculated from measured bulk densities under known packing conditions, i.e., for known void fractions. From a knowledge of the true void fraction, ν, of the bulk material for a narrow size fraction of the spray-dried product, the particle density of the mass-mean size of the fraction, ρ_f, was calculated from the simple relation, $\rho_f = \rho_b/(1 - \nu)$, where ρ_b = bulk density. (Details are given in the Appendix.)

Spray droplet diameter

The diameter of the original spray droplet was calculated from the material balance given by Equation (5). It is apparent that this procedure depends on the following assumptions and data:

1. All solids in the initial drop end up in the final dry particle.
2. There is no variation in initial concentration, C_o, with drop size.
3. Dry particle size, x_f, is known.
4. Dry particle density, ρ_f, is known.

The methods of establishing the particle size distribution and void fractions are given in the Appendix.

Important Results

In presenting the results of this study, it was necessary to prepare numerous curves of the experimental data in order to present the results adequately. Generalized correlations were not feasible. Accordingly, the curves shown in Figures 2 to 9 present the effects of air temperature, feed concentration, and feed temperature on particle density, and on the dry particle-to-spray droplet diameter-ratio.

Sodium sulfate

The operating data for all sodium sulfate runs are tabulated in Table 2. The spray-dried particles obtained from sodium sulfate solutions are typical of those products which are formed when a soluble, inorganic salt crystallizes from solution during the drying process. The crystalline nature of the particles obtained is shown in Figure 1.

With reference to Figures 2 to 6, the following observations can be made:

Inlet Air Temperature

Figures 2 and 3 show that inlet air temperature had the same effect on the variation in particle density and dry particle diameter for feed concentrations of 10 and 20%. However, for a feed concentration of 15% solids, the inlet air temperature showed an appreciable variation in its effect on these properties. Thus, whereas the air temperature produced little change in the dry product–spray droplet diameter-ratio for 10 and 20% feeds, for a 15% feed as the air temperature changed from 333 to 531° F. this ratio changed significantly.

Table 3 compares this ratio for the various temperatures and concentrations.

It is apparent from Table 3 that at 15% solids, the air temperature had a more pronounced influence on the ratio of final-particle diameter to spray-droplet diameter than at 10% or 20% solids. The reason for this is not entirely clear. Apparently at 20% solids the solution concentration was near enough to saturation that a variation of particle properties with size class was not obtained because a solid structure was formed almost instantaneously and independently of droplet size. At 10% solids the liquid to solid ratio in the feed was so high that a solid structure was not formed until considerable evaporation of the water had taken place, again producing particle properties which did not vary much with size class.

In all cases, it was observed that the density of the particles decreased as particle size increased for all conditions of air temperature, feed temperature, and feed concentration, and that this variation was as great as fourfold. This explains, in part, why spray-dried products of predominantly small particles frequently exhibit higher bulk densities than the corresponding product composed of larger particles.

Feed concentration

Figures 4 and 5 show that feed concentration had a marked influence on particle properties, the data for 15% solids, however, showing anomalous behavior compared with 10 and 20% solids. In general, as feed concentration decreased, the dry particle size decreased and particle density increased, although the data for 15%

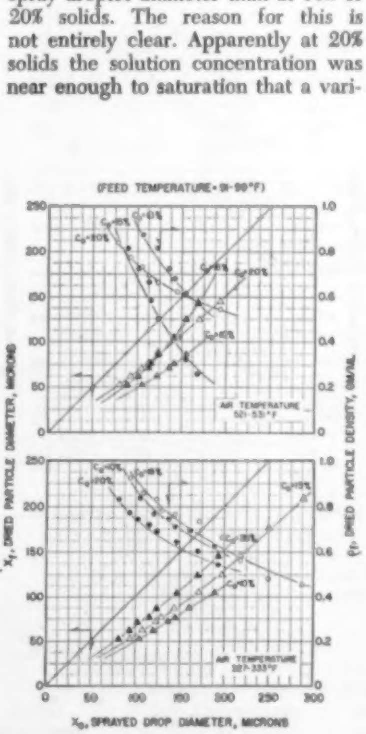

Figure 4. Effect of feed concentration on properties of dried sodium sulfate drops (feed temperature=91-99° F.).

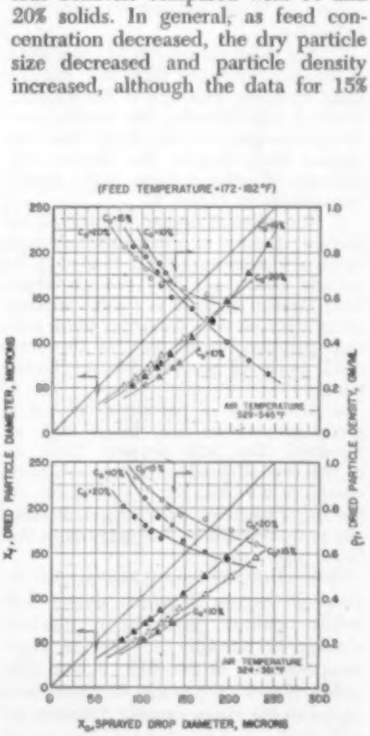

Figure 5. Effect of feed concentration on properties of dried sodium sulfate drops (feed temperature=172-182° F.).

. . . photomicrographs explain in part why the density of spray-dried particles varies inversely with the particle diameter.

solids were not consistent in all respects with regard to particle density. These results are consistent with the theoretical predictions of Equations (1) and (6), as summarized in Table 1.

Feed temperature

Feed temperature had only a slight effect, except for a feed concentration of 15% solids, Fig 6. For this concentration, particle density increased and dry particle diameter decreased as feed temperature increased. For concentrations of 10 and 20% this tendency was negligible, and one would conclude for these concentrations that feed temperature had no effect on particle properties within the range 95 to 180° F. feed temperature.

Coffee Extract

The operating data for a commercial coffee extract are summarized in Table 4.

Effect of air temperature

Figure 7 summarizes the data on the effect of inlet air temperature on properties of spray-dried coffee particles. It is of interest to note the following:

1. The dried particles in all cases were of smaller diameter than the original spray droplets, although a film-forming material, such as coffee, has usually been thought to give particles *larger* than the original spray droplet. The film-forming tendency of coffee is shown in the photomicrographs in Figure 9.
2. The effect of drying temperature on particle density is pronounced. For a range of temperatures from 324 to 513°F. particle density can vary two- to threefold. Density in itself is a more striking effect than particle diameter, since particle diameter varies only as the one-third power of particle density (Equation (5)).
3. The range of particle density at a given temperature may be as high as threefold. The bulk density, Table 4, of the over-all product corresponds very nearly, in all instances, to the density of the larger particles, that is, the bulk density is determined by the particles in the larger size ranges.

The effect of feed concentration is given in Figure 8, which shows that solids content produced a marked change in particle diameter at high temperatures. At 500-518° F. and 22% solids, the dried particle diameter was equal to the spray droplet diameter at a particle size of about 187μ. As in the case of sodium sulfate, the effect of solids content is less pronounced at temperatures in the range 323-329° F.

Clay Slip

Clay slip was not readily atomized with the pressure nozzle at high feed concentrations because of the non-Newtonian characteristics of the feed and the small orifice size used. It was not until the solids content had been reduced to 6% by weight that atomization with the centrifugal pressure nozzle with an 0.0008 in. diam. orifice was achieved. Consequently, the effects of varying the initial air temperature and feed temperature were scarcely detectible. However the trends were the same as those observed for sodium sulfate, that is, at high air temperatures the higher feed temperature gave a more dense particle than the lower temperature.

The operating data for the tests on clay slip are given in Table 5. Figure 10 shows photomicrographs of the clay particles, which are interpreted below.

Physical Structure of Spray-Dried Particles

Photomicrographs of the spray-dried particles explain, in part, why the density of spray-dried particles varies inversely with the particle diameter.

Sodium sulfate particles

The particles were suspended in a matrix of the correct refractive index to allow the optical field to penetrate their walls. The conditions for photography may be found in Literature Cited *(3)*.

The dried particles had a refractive index of 1.477 and that of the suspension media was 1.51. This made possible optical penetration into the particle with enough contrast to estimate the particle wall thickness at that part of the particle which lay within the optical section. In obtaining a measure of a particle's wall thickness, the optical sections were taken at the

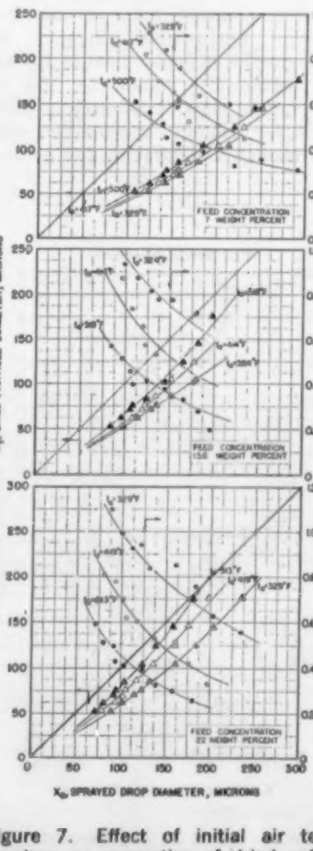

Figure 7. Effect of initial air temperature on properties of dried coffee extract drops.

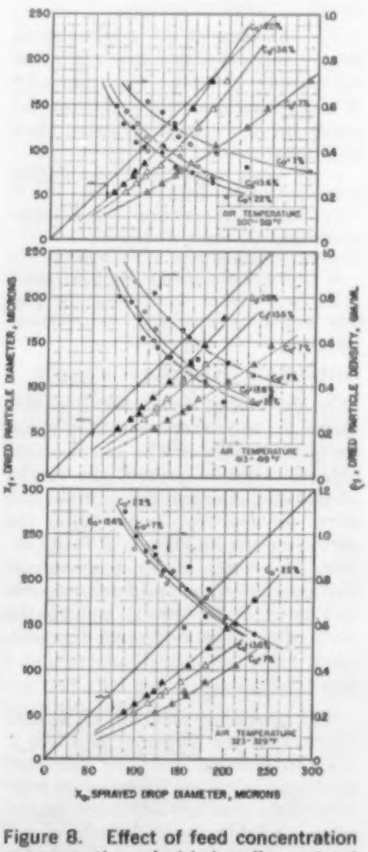

Figure 8. Effect of feed concentration on properties of dried coffee extract drops.

equatorial plane. For sodium sulfate this is shown in Figure 1.

These photographs indicate that the salt crystals were concentrated at the particle surface with a less dense crystalline structure set up inside the particles. The effective wall thickness of the larger particles was comparable to that of the smaller particles, and the internal crystalline structure appeared more dense for the smaller particles than for the larger ones. Therefore the smaller particles would be expected to be more dense than the larger ones.

The structure of the particles indicated that once a solid wall had been set up no change in dimensions occurred throughout the remainder of the drying process. Also the particles were nearly spherical and the walls were of uniform thickness. This suggested that the drops dried symmetrically, that is, the drops were randomly spinning such that the drying rates were averaged out uniformly over the drop surface.

Coffee extract particles

The dried particles were suspended in a matrix of USP grade, extra heavy mineral oil. Entrapped air was partially removed by placing the suspended particles under a vacuum. However, it was not possible to remove all the entrapped gases. In Figure 9 the optical sections are taken at the equatorial planes of the particles.

These particles were exceptionally thin walled and the smaller particles possessed thicker walls than the larger ones. No solid material appeared to reside in the particle interior as in the case of the inorganic salt. Again it was evident that the smaller particles were more dense than the larger ones.

The shape of the particles indicated that they underwent expansion and contraction during the drying process. However, the particles gave no indication of collapsing markedly at the end of the drying cycle. Motion pictures of an evaporating coffee drop showed that expansion of the particle occurred near the end of the drying, that is, after most of the water had been evaporated.

Clay slip particles

Figure 10 attempts to establish the wall thickness of clay particles which were suspended in a matrix of USP grade, extra heavy mineral oil. Without exception these particles collapsed at the end of the drying cycle and took on the appearance of dried apricots. Because of their physical shape, it was difficult to obtain an optical section which would best give an estimate of the wall thickness.

These photographs indicate that the collapsing of the particles might have been caused by capillary action of the dried surfaces drawing liquid and solids outward uniformly around the drop, thus creating subatmospheric pressures within the particles, resulting in an eventual collapse of the particles.

Discussion

The results of this study showed that the effects of operating variables on the properties of spray-dried particles are dependent upon the type of material being spray dried. For crystalline materials, typified by sodium sulfate, the effect of inlet air temperature on particle density and hence final particle diameter was not significant at extremely low solution concentrations or at solution concentrations near saturation. However, for coffee extract, a film-forming material, the inlet air temperature showed a very pronounced effect over a wide range of feed concentrations.

On the other hand, feed concentration showed a marked influence on the properties of the sulfate particles over a range of air temperatures, while the ef-

TABLE 1—PREDICTED EFFECTS OF DRYING VARIABLES ON x_f/x_o AND ρ_f

Drying variable	Particle-droplet diameter-ratio, x_f/x_o	Particle density, ρ_f
Feed concentration, C_o	Should increase as C_o increases.	Should decrease as C_o increases.
Heat transfer potential, $(\Delta t)_m$	Should increase as $(\Delta t)_m$ increases.	Should decrease as $(\Delta t)_m$ increases.
Initial droplet diam., x_o	Should increase as x_o increases.	Should decrease as x_o increases.
Humidity of drying air	Should decrease as the humidity increases.	Should increase as the humidity increases.

TABLE 3.—EFFECT OF AIR TEMPERATURE ON DRY PARTICLE—DROPLET DIAMETER RATIO FOR SODIUM SULFATE

Mass-mean dry particle diam., μ	Dry particle—droplet diameter ratio, x_f/x_o — $C_o = 15\%$ 531 °F.	426 °F.	333 °F.	$C_o = 10\%$ 525 °F.	333 °F.	$C_o = 20\%$ 522 °F.	327 °F.
53	0.592	0.628	0.568	0.499	0.506	0.655	0.657
77	0.666	0.678	0.599	0.541	0.533	0.684	0.690
106	0.740	0.707	0.614	.....	0.555	0.724	0.715
146	0.867	0.772	0.671	.....	.....	0.753	0.757
208	.....	0.878	0.721	.....	.....	.....	.....

TABLE 6.—COMPARISON OF THE FREE-SETTLING AND UNIFORM-PACKING METHODS FOR PARTICLE DENSITY DETERMINATION

Spray-dried Sodium Sulfate (Run No. S-7)
Particle Density, g./cc.*

Sieve fraction mesh	Uniform packing	Free settling	Per cent deviation
+325, −270	0.842	0.824	2.48
+270, −250	0.777	0.811	4.37
+250, −200	0.734	0.739	0.68
+200, −170	0.695	0.683	1.76
+170, −150	0.665	0.714	7.37
+150, −115	0.625	0.622	0.48
+115, −100	0.594	0.568	4.57
+100, −80	0.549	0.558**	1.64

* All materials were oven dried, thus these densities are on a moisture-free basis.
** Calculated by the intermediate settling law.

TABLE 7.—ILLUSTRATIVE EXAMPLE

Initial drop diam.	Evaporation rate % that of pure water x_f, μ	ρ_f, g./ml.	Evaporation rate same as that of pure water x_f, μ	ρ_f, g./ml.	Experimental test, run No. S-7 x_f, μ	ρ_f, g./ml.
50	43.5	0.350	37.2	0.716	31.5	1.04
100	87.5	0.346	75.2	0.552	67.0	0.74
250	223.0	0.327	198.4	0.470	200.0	0.48

. . . particle properties calculated in some previous studies disagree somewhat with those obtained experimentally.

fect of feed concentration on coffee-extract particles was not as pronounced on a relative basis.

Feed temperature did not influence sodium sulfate particle properties at low feed concentrations or at feed concentrations near saturation. It was significant at 15% solids.

These results indicate that depending on the material being dried, particle properties of spray-dried materials can be varied within a limited range by changing air temperature, feed concentration, and feed temperature. Regardless of type of material, the final particle diameter rarely equals the initial spray droplet diameter. Only in the case of film-forming material dried at a sufficiently high feed concentration and at temperatures above the boiling point can the final dry particle diameter be expected to equal or exceed the initial spray droplet diameter. (Compare data of Table 4 and curves of Figure 7.)

Particle density may vary over a three- to four fold range, but the bulk density appears to be determined primarily by the density of the large-diameter particles. The bulk density of a spray-dried product seldom approaches within 50% of the true density of the solid; that is, for the case of sodium sulfate, the true density of this salt is 2.7 g./ml. The highest bulk density measured was 0.5, and the highest particle density was about 1.0 for a dry particle diameter of 50μ. Bulk densities are listed in Tables 2, 4, and 5.

1. The particle density of spray-dried materials can vary over a three- to fourfold range. However, bulk density cannot be varied more than 50% for crystalline soluble materials, and even less for suspensions, such as clays. Bulk density can be varied over a two- to threefold range for film-forming materials, such as coffee extract.

2. Variations referred to in (1) are brought about by changes in the operating conditions, such as air temperature, feed concentration, and feed temperature. Further research should be conducted on the problem of the drying behavior of droplets as affected by changes in liquid properties of the droplet, both chemical and physical. In particular such studies would be of interest in spray-drying suspensions, such as clays, ferrites, etc.

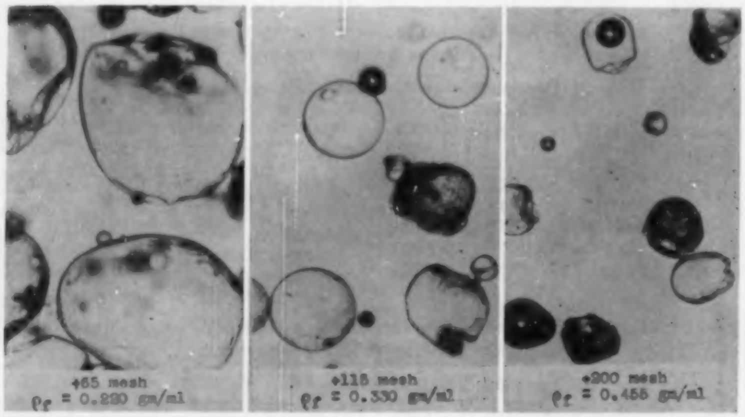

Figure 9. Spray-dried coffee extract showing variation of wall thickness with particle size.

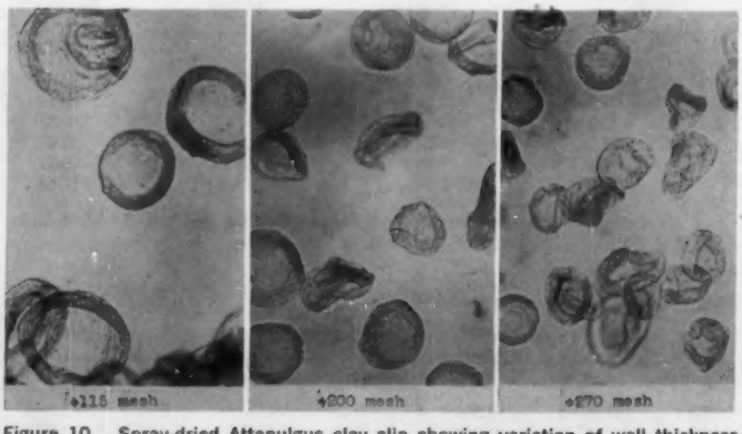

Figure 10. Spray-dried Attapulgus clay slip showing variation of wall thickness with particle size.

A Comparison with Theory

Charlesworth and Marshall *(2)* presented an example of the application of their semitheoretical equation for predicting drying time to the drying of an aqueous sodium sulfate droplet. The material dried was the same and the conditions used in the calculation were practically identical with those of Run S-7, Table 2.

The time necessary to set up a solid structure was calculated for average drying conditions, and for a reduction in drop volume assumed equal to the volume of water evaporated. Charlesworth and Marshall suggested that the rate of evaporation from a salt solution be taken as two-thirds that of a pure water drop. Calculated values of particle properties for three initial drop sizes are compared in Table 7. Calculations of properties were made both for initial drying rates equal to that of water and two-thirds that of water.

The particle properties calculated by Charlesworth and Marshall disagree somewhat with those obtained experimentally. However, by assuming that during the constant-rate period a droplet containing solids dried at a rate equal to the evaporation of a pure water droplet a closer agreement with the experimental result was attained. These results suggest that the disagreement with theory increased as the drop size decreased. This disagreement might be accounted for, in part, by the fact that the semitheoretical equation developed by Charlesworth and Marshall was based on the assumption of zero relative air velocity which implies a lower evaporation rate than actually occurs in practice.

Acknowledgment

The authors wish to express sincere appreciation to the Wisconsin Alumni Research Foundation, the University of Wisconsin Engineering Experiment Station, and the Procter & Gamble Company for financial support of this research study.

Notation

b = constant

C_f = weight fraction of solids per unit weight of product in a dried particle.

C_o = weight fraction of solids per unit weight of solution in a sprayed drop.

C_s = weight fraction of solute per unit weight of solution at conditions of saturation.

D_l = diffusivity of diffusing component across transfer path in liquid phase.

F = factor defined by Equation (7).

k_f = average thermal conductivity of transfer path in vapor phase.

$(\Delta t)_m = (t_s - t_l)_m$, mean effective temperature difference between the main body of the drying medium and the temperature at the liquid-vapor interface of a drying drop.

x_f = final diameter of a dried particle.

x_o = initial drop diameter.

$$\epsilon = \frac{8k_f(\Delta t)_m}{\lambda \rho_l} = \text{evaporation coefficient.}$$

λ = latent heat of vaporization.

ν = void fraction.

ρ_b = bulk density.

ρ_f = density of a dried particle.

ρ_l = density of a pure liquid or the density of a pure solvent for a solution.

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APPENDIX

Particle Density from Free Settling Velocity

One indirect method of determining a particle's density is by measuring its terminal settling velocity. This procedure was used as a check on the method of uniform packing which was used to make all particle density determinations.

The terminal velocity measurements were made with a Sharples Micromerograph, a device which determines particle size distributions from the rate of settling in air. The procedure used was as follows: A 25 to 30 mg. sample from a fraction of narrow size range was dispersed at the top of a 4-in. diam., 8 ft. high vertical, air sedimentation column. At the bottom of the column the sample was collected on a balance pan. The balancing mechanism was connected to a recording instrument which had a chart speed of 6 in./min. Thus, the chart recorded a cumulative weight-time curve in the units of $x_f\sqrt{\rho_f}$ vs. time. The time at which the sample was dispersed was also recorded on the chart. Using the fact that the volume distribution was symmetrical and assuming minor variation of density within the narrow size fraction, the settling time for the mass-mean size was designated as that point where 50% of the sample was down.

This method of determining particle densities was checked against a sample of known particle density in which soda-lime glass microspheres were used. Due to the high density of the microspheres (2.47 g./cc.) only the +325, −270 mesh sieve fraction could be used. Figure 11 illustrates the method by which the cumulative weight-time curve was analyzed to give a particle density of 2.48 g./cc. with an error of less than 0.4%.

Particle Density from Uniform Packing

Particle densities were determined by measuring the bulk density of a narrow size fraction under known packing conditions. If the true void fraction of the bulk material were known for a sample from a sieve fraction of spray-dried material, the calculated particle density of the mass mean of the fraction resulted.

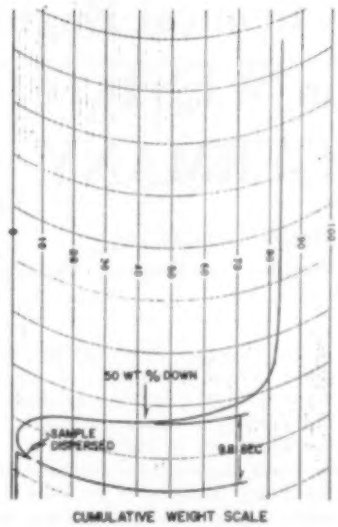

Figure 11. Cumulative weight—time record from Sharples micromeragraph (sample: glass microspheres; +325, −270 mesh; density=2.47g./ml.; vol. mean diam. =55 μ.

This method was used throughout this work for measuring particle densities.

The void fraction of the random-type packing was determined by the use of particles of known density. Solid glass microspheres were screened in the same manner as the spray-dried product which was to be analyzed. The bulk density was determined under known packing conditions. From these measurements the void fractions could be calculated for every size class. Results are presented in Figure 12. It was noted that the void fraction tended to increase somewhat at the smaller particle diameters. This effect was observed by Andreasen and Andersen *(1)* and also by Sinnat and Slater, as cited by Rose *(7)*.

The particle densities for the dried materials were calculated from the bulk densities using the values in Figure 12 for the void fractions.

Some idea of the accuracy of this method was obtained by the reproducibility of the voids for a number of determinations with the glass microspheres. From several tests it was estimated that the void fraction would not vary more than 2% over 95% of the determinations. The maximum error in the particle density was then estimated to be 2% considering the balance used to be sensitive to within one milligram.

As an independent check on the uniform packing method of determining particle densities, the particle densities for one test run (S-7) were also measured by the free-settling method. The results are given in Table 6. From these data the maximum deviation between the two methods was predicted to be less than 8.5% for 95% of all comparisons.

Presented at A.I.Ch.E. meeting, Seattle, Washington.

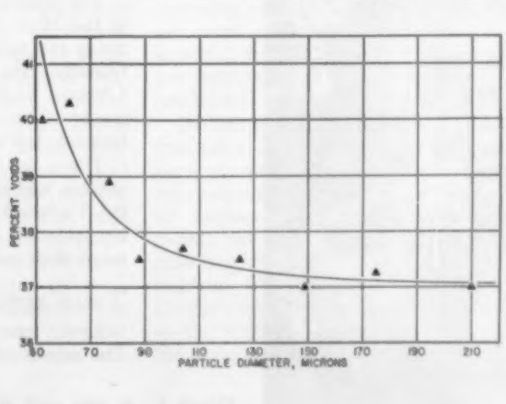

Figure 12. Relationship between percent voids and particle size in uniform packing device for glass micropsheres (density=2.47 g./ml.) (vibration time = 20 sec.).

Chemical Engineering in WEST GERMANY

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THE FEDERAL REPUBLIC OF GERMANY (West Germany), of all the major industrial powers, is alone in not holding chemical engineering a special branch of engineering *(2)*. In spite of this negative attitude, the flourishing condition of the West German chemical industry is too well known to permit any doubt that the West Germans have found adequate means to handle the development of their chemical process industries.

It is the purpose of this paper to examine briefly current West German practices, some of the reasons for the differences which exist, and to express a few constructive comments gained primarily from West German representatives themselves as to the virtues and defects of their present system.

A questionnaire was assembled in the summer of 1957 and sent to a number of important figures in West German chemical companies. The petroleum companies were not solicited, as they are mainly non-German in ownership and use primarily American technology. Time did not permit examining the views of other allied process industry companies. After the questionnaire was forwarded, the author discussed the subject personally with most of the recipients; the synthesis of his impressions is presented here anonymously.

In addition, certain pertinent articles from the German literature were translated and studied. Information was also obtained from individuals trained in United States chemical engineering methods who have worked in West Germany or elsewhere for German companies.

The spirit of the replies received always was that of constructive interest in the evolution of West German industrial and educational practices, without concomitant criticism of United States practice.

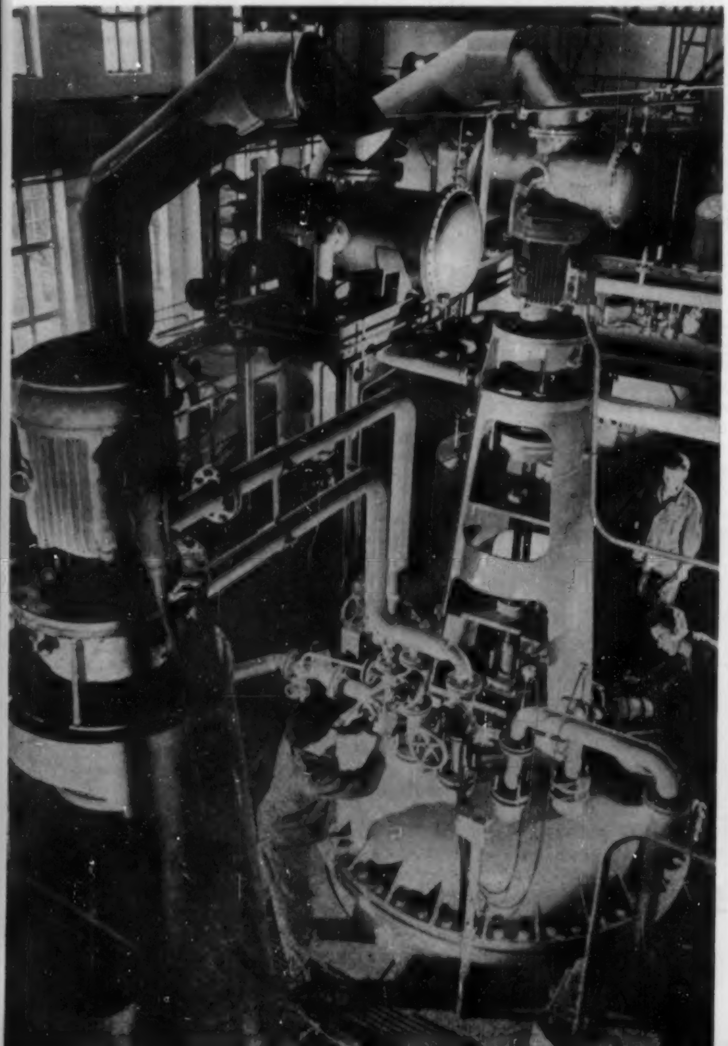


Figure 1. A new unit at the Badische Anilin & Soda-Fabrik plastic plant at Ludwigshafen.

Present conditions in West German chemical industry

NATURE OF CHEMICAL INDUSTRY. Before World War II, the I. G. Farbenindustrie A.G. constituted approximately eighty per cent of German chemical production. Today, the four largest companies, Farbenfabriken Bayer, Badische Anilin und Soda Fabrik, Farbwerke Hoechst, and Chemische Werke Huls, represent rather less than half of this proportion of West German production, each ranking with the larger United States companies.

WEST GERMAN EDUCATION PATTERN. Some 95 percent of graduate industrial chemists hold a Ph.D. Their education includes 13 years schooling through the secondary curriculum, and eight of college-level work; the average age at graduation is about 27 years. Universities and technological institutions (Hochschulen) both teach chemistry. Engineers are not generally graduated from universities but only from Technische Hochschulen. They usually require four years of training after the secondary schools, and are therefore about 23 years old when they receive the degree of Diplom-Ingenieur, which is perhaps more like the M.S. in the United States. The Dr.-Ing. degree is rare in West Germany.

The principal engineer encountered in the West German chemical industry is the mechanical engineer. More recently, the Verfahrens Ingenieur (Process Engineer), a mechanical engineer with some chemical engineering training, has appeared.

There are also engineering trade schools which give less training than the Technische Hochschulen, supplying technical assistants, designers, and some draftsmen.

Team approach

EVOLUTION OF PROCESS ENGINEER. The accelerated requirement for proc-

ess engineers has been brought about by the greatly changed character of the postwar chemical industry. Since, however, most of this demand is unsatisfied as yet, the West German industrial technique still involves the traditional team approach, in particular the combination of the chemist and the mechanical engineer, who learn their respective roles in industry. Neither in industry nor in the schools is there found the individual trained both as a chemist and an engineer.

The demand for process engineers is recent *(3, 4, 5)*. The first Technische Hochschule to originate such a curriculum was Karlsruhe (1928). The other five Technische Hochschulen curricula for process engineers, at Berlin, Aachen, Braunschweig, Hannover, and Munich have been in existence only since 1952. The Technische Hochschule at Darmstadt teaches chemical technology rather than process engineering *(6)*; Stuttgart's Technische Hochschule teaches neither.

Education for chemical process industries

Table 1 presents a typical picture of some comparative curricula.

TABLE 1

Course	Per cent of total time spent in higher education (est.)		
	U. S. chem. engr. (B.S.)	West German process engineer	West German chemist
Chemistry	20-27	8-9	81
Chemical engineering	24	12-15	5
Other engineering	8-18	25-35	..
Mathematics	13	12	3
Physics	8	14*	7
Mechanics	4	11	..
Cultural	15-21	10	4

* With fluid dynamics and thermodynamics

chanical engineering faculty. However, Karlsruhe may shortly establish a special department of process engineering.

The distribution of courses for the increasing number of Master's and Doctor's men in United States chemical engineering would be different from those shown with higher percentages in chemical engineering.

The chemical technology course at Darmstadt involves special industrial chemistry courses, less pure chemistry and research, and recently some engineering and design subjects *(7)*.

Other information on curricula may be found in various publications *(8, 9)*.

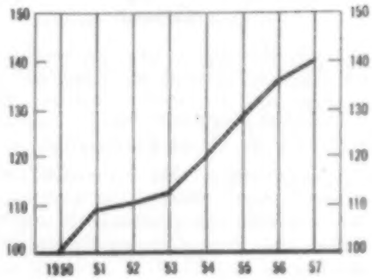
SOME STATISTICS. The West German Technische Hochschulen graduate roughly 100 process engineers per year, who constitute about one per cent of West German engineering graduates. At Karlsruhe there is one process engineering graduate to two mechanical engineering graduates; in the other five the ratio is more nearly one to six. Altogether in West Germany there are about 1000 graduate process engineers. There are several thousand more who are process engineers by practical experience and interest. There are only about twenty chemical technologists graduated annually from Darmstadt among 1000 total chemical graduates, 70% of whom are university men.

Since the graduates in process engineering supply less than about ten per cent of the demand for their services, the other more than ninety per cent must be obtained from the mechanical engineering graduates.

By comparison, the United States graduates some three to four thousand chemical engineers every year, who constitute about ten per cent of all engineering graduates. Perhaps twenty per cent of these chemical engineering graduates obtain advanced degrees. The number of graduating Doctor's men in chemical engineering in the United States is probably of the same order of magnitude as the number of process engineering graduates in West Germany.

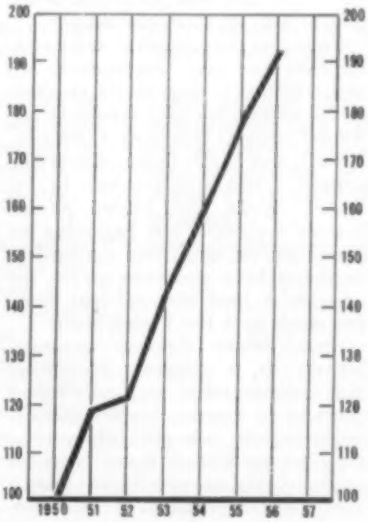
With regard to the process engineer's curriculum, in West Germany the process engineer is considered to be largely an equipment engineer. His chemical engineering training is primarily in unit operations, based on methods quite similar to those used in the United States. The curriculum does not pay much attention as yet to process design, instrumentation, material and energy balances, applied chemical kinetics, and applied chemical thermodynamics. Cultural subjects, as well as mathematics and basic sciences, are partially covered in the secondary school, so that these percentages should normally be lower than those for United States chemical engineering undergraduates. Instead, there is heavy mechanical engineering training, and more physics. Process engineering is a branch of the me-

EMPLOYMENT indices for West Germany's chemical industry*



*Source - O. E. E. C. statistical bulletins, 1958

PRODUCTION indices for West Germany's chemical industry*



*Source - O. E. E. C.'s "The Chemical Industry in Europe," 1956.

PHILOSOPHY OF EDUCATIONAL PROGRAM. The West German educational system is designed to train chemists in research and research-mindedness, as scientists of profound understanding in their field. By and large, the Ph.D. chemist has little or no knowledge at graduation of industrial equipment or the many problems associated therewith.

For process engineering the goal of the educational system is to adapt the traditional mechanical engineering curriculum so as to permit the process engineer to understand the language of the chemist.

The West Germans insist that a process engineer must not be a specialist, not even for the chemical industry, but must be trained to fit into a wide type of industry such as foods,

West Germany

continued

minerals, etc.; hence, their preference for "process" instead of "chemical."

Chemical engineering practice in West Germany

COMPARISON. Table 2 presents in summary form some of the similarities and differences between United States and West German industrial practices.

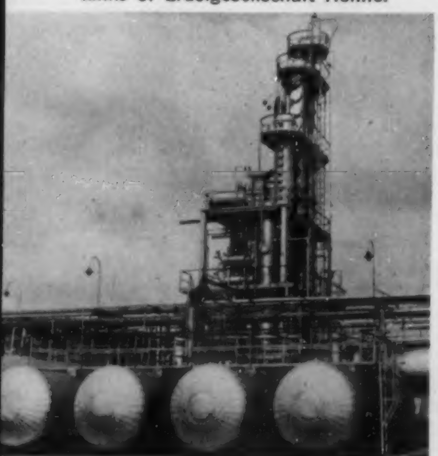
Table 3 shows how the various professionals are distributed in the United States and in West Germany.

The American chemical engineer is distributed in a somewhat wider functional spectrum than is any one of his counterparts in West Germany.

CHEMICAL ENGINEERING RESEARCH. In West Germany, fundamental research is usually done by the faculties of the universities and associated institutes (such as Hamburg, Göttingen, Berlin), and at the Technische Hochschulen. Little is as yet done by industry, unlike the United States. Process engineers are beginning to move into the field, and mechanical engineers have also been active, for example, in fluid flow and heat transfer, much as in the United States.

SOME WEST GERMAN ACHIEVEMENTS. It is generally recognized that unit operations, and more recent concepts in kinetics, applied thermodynamics, etc., are primarily attributable to the United States chemical engineer. He has also figured prominently in the evolution of new techniques such as the turbo-grid tray, centrifugal extractors, cyclonic scrubbers, sorption systems, gaseous diffusion methods for isotope separation, etc. In general, fewer such innovating concepts and methods have appeared in Germany, although names such as Eucken and Jakob are world famous, and West German teams have produced such new equipment and techniques as the Winkler generator, thin film evaporators, and other novel designs.

Figure 2. Tower and gasoline storage tanks of Erdolgesellschaft Hohne.



Roy Bernard, Inc.

There have been, nevertheless, important contributions by German mechanical engineers to this area, as in fluid flow and boundary layer work, heat transfer and fluidization. Moreover, German contributions to chemical process work have been outstanding and have been made primarily by chemists, assisted by mechanical engineers and more recently process engineers. Many of these process developments involved continuous processing, and in fact the Haber process goes back to World War I; it was one of the first really continuous chemical process techniques in the world. Frequently cited by the West Germans in this category are ammonia synthesis, methanol synthesis, Fischer-Tropsch and Oxo processes, Bergius coal hydrogenation, Linde low-temperature liquefaction, Buna-S rubber, Reppe acetylene chemistry, acrylonitrile and acrylonitrile fibers from acetylene and HCN, diisocyanates, polycarbonates, and Ziegler low-pressure polyethylene.

DIFFERENCES BETWEEN U. S. AND WEST GERMAN PRACTICES. An examination of the industrial practices as described above suggests that both the United States and West Germany really employ a team approach but that the leadership in the United States is more often in the hands of the chemical engineer, and in West Germany in those of the chemist. Aiding the chemist in his team are the mechanical engineer, and in smaller but increasing numbers, the process engineer.

Industrial practice in the United States most often involves a larger team consisting of a chemical engineer (frequently of graduate caliber) with a chemist and a mechanical engineer. In some cases, a United States chemical engineer thinks much like a chemist, in other cases more like a mechanical engineer; but he is usually a distinctive type of engineer, and in this respect is a specialist *in addition* to those working together in West Germany rather than *in place of* any one West German specialist.

Eight reasons for differences between U.S. and West German practice

1. Chemical engineering arose earlier in the United States than in Germany. As a result of a forty-year head start, there are many more schools of chemical engineering in the United States than there are schools teaching process engineering in West Germany, and far greater numbers of chemical engineers.

2. West Germans credit the rise of the petroleum industry for the rapid growth of the American chemical engineering profession (10). Refining necessarily had to be on a continuous scale and because adequate fundamental data applicable to the complex mixtures handled were rarely available, the applied physico-chemical approach, the pragmatic attitude so suited to the genius of the American people, and the unit operations concepts found just the right reception from the petroleum refining industry. The West Germans also point out, quite justly, that the chemical aspects of petroleum refining were comparatively simple compared with those of the dye-stuff industry, so that the heavy emphasis on the engineering function in the American chemical engineer's training was proper.

3. The size of refining and petrochemical units forced the American chemical engineers to design carefully and conservatively, with semi-empirical methods and minimum experimentation. In Germany, however, before the war, the scale of operation was generally smaller and the variety of products was much greater; there was also less competition than in the United States and more time to work problems out in the plant, including training of "chemical engineers" in fact. The great postwar expansion in both the United States and West Germany has resulted in many more large continuous plants, so that the older West German practical learning methods have become less economically permissible.

4. Industrial training of technicians has been more extensively practiced in Germany. I. G. Farbenindustrie before the war had less than one per cent turnover per year, and dominated the industry. On-job training was therefore an excellent and secure investment. However, the lack of the systematizations introduced by the American chemical engineering discipline cost the German industry much difficulty, money, and time; such practices probably were not excessively burdensome to a large entity like I. G. Farbenindustrie, which had the advantage of evolving people trained especially to suit its requirements. Dr. Carl Bosch's account of

Table 2.—Chemical Engineering Practice in U. S. and West Germany

Function	Example of Functions	Who Performs in U. S.	Who Performs in West Germany	Where Performed in West Germany
1. Provision and correlation basic data	Correlations such as Benedict eq. of state	Chem. engr. and chemist	**Chemists (occasionally process engrs. and physicists)**	**Research lab; also occasionally in process eng. lab**
2. Dev. design information	Pilot plant dev. of processes or equip.	Chem. engrs., aided by chemists and mech. engrs. and technicians	**Chemists (90%); process engrs. and mech. engrs. (10%); aided by technicians**	**Res. center (pilot plant, mostly in glass); plant lab (semicommercial units)**
3. Process dev.	Economic comparison of processes; translations of data and designs to probable commercial form through process flowsheets, equip. sizing and selection; direction of res. programs	Chem. engrs.	**Chemists, aided by process engrs., physicists, and mech. engrs.**	**Pilot plant or eng. dept. large chem. cos.**
4. Equip. dev.	New processing techniques such as fluidization; new equip. dev.	Chemical engrs. and mech. engrs.	**Chemists and mech. or process engrs.**	**Large chemical co. eng. departs., and equip. mfrs.**
5. Economic evaluation	Definitive capital cost & project profitability studies; dev. of costing procedures; decisions to build or expand	Chem engrs., aided by mech. engrs.	**Chemists with extensive industrial experience; mech. engrs. aided by process engrs.**	**Large company eng. or administrative dept.; also, executives (vorstand members) often decide on selection of processes and programs**
6. Detailed plant design	Piping, civil, electrical, pressure vessel, instrumentation, design	Mech. engrs., and others; chem. engrs. often act as project mgrs. or coordinators	**Mech. or process engrs., aided by others such as technicians and draftsmen**	**Large company eng. dept.**
7. Plant operation and improvement	Removing bottlenecks; maintaining production; reducing costs	Chem. engrs., also chemists	**Chemists, aided by process or mech. engrs. and physicists**	**Plant**
8. Management	Direction of enterprises at highest or intermed. levels	Chem. engrs. and chemists (among others, often non-technical)	**Chemists, also lawyers, commercial specialists (process or mech. engrs. in certain tech. depts. such as eng.)**	**Chemist dominant in direction of res., mfg., and in gen. management (vorstand)**

his struggles in developing the continuous ammonia process gives an excellent perspective on this period in German chemical history *(5)*.

5. *Geography has had an important effect.* United States plants are widely scattered, and even today, except in some cases, make only limited numbers of products in one plant. One does not often see in the United States such huge complexes as exist at Hoechst, Leverkusen, Ludwigshafen, etc., in which much of the West German chemical industry is still concentrated. Therefore, in the American plants, chemists are not overwhelmingly more important than engineers, and one person can combine the function of both, according to the West Germans.

6. *While chemical production facilities in West Germany are no longer very dissimilar to those in the United States, the West German goals are not identical with those of the United States.* Only lack of time and educational facilities has retarded development of West Germany's chemical plant techniques. But the West German executives stress that in the future their chemical industry can not compete with the United States mass-produced chemicals on a purely economic basis. To succeed, they will need new, complex, and original chemical reactions, e.g., new polymers. This work requires the type of training exemplified by the Ph.D. West German chemist. Hence, the West Germans still stress the chemist's role in their industry, but they freely recognize that the process engineer (or mechanical engineer), and also the chemical technologist, are his increasingly important col-

TABLE 3—Estimated Per Cent Distribution of Employment

Function	U. S. chemical engineer	West German process engineer	West German mechanical engineer	West German chemist
Chemical and engineering research and development	31	20	5	20
Consulting	4	5	5	1
Management	10	1	2	5
Teaching	3	2	..	2
Technical writing	1	..	..	1
Design	13	40	35	5
Analysis and Testing	5	5	..	6
Production	28	25	50	55
Technical sales and services	3	1	..	3
Other	2	1	3	2

laborators, and the differences between the United States and West German approach are thus diminishing. However, the West Germans do not yet fully understand the important advance represented by the M.S. and Ph.D. U. S. chemical engineering training, in dealing with the more complex chemical and engineering problems of today's industry.

7. *Chemical engineering has been the glamour field in the United States as against chemistry in Germany.* The glamour of chemical engineering in the United States comes partially from the high social standing of engineering in a country which had a continent to develop, and comes partially also from monetary considerations. In Germany, on the other hand, chemistry has been an honored profession for a hundred years.

8. *The large engineering and contracting firm has not yet developed as widely in West Germany as in the United States (11).* Most of the West German engineering design work is done by the large chemical companies themselves (who occasionally do a job for others, particularly if they are licensing a process), and this permits not only on-job training but an acceptance of a certain amount of experimentation in the plant. The United States engineering company's development accelerated the demand for the chemical engineer since a properly trained chemical engineer was economically more justified than a team might be.

Some West German self-criticisms

Opinion in West Germany is not complacent about the situation today, and healthy differences of viewpoint exist. Industry is bringing great pressure to bear on the Technische Hochschulen and universities to modify the curricula, add teachers, and increase number of students. The long traditions of the schools change too slowly to satisfy many. The absence of important industrial consulting activity by university professors, the relatively low salaries but the high standing of scholarship and scholars generally in West Germany, and the universal shortage of funds, tend to keep the faculties from responding immediately to the industrial viewpoint.

The influence of a pure chemist if misapplied has sometimes tended in the eyes of experienced West German management to result in processes being commercialized before they are ready economically or technologically. Industrial orientation courses are helping to reduce this risk *(2)*.

Some West German executives feel that the wide gap in viewpoint and training between the members of the two-man team tends to make more difficult invention in the broad territory that lies between them. One outstanding individual is still the principal source of fundamental inventive creation. Where it is the chemist who is inventive, his contributions tend to the pure chemical side; where it is the mechanical engineer, his inventions go to fluid flow, heat transfer, design of special high-pressure equipment. But what is missing, these executives say, is the invention in the middle: either of techniques or equipment design (largely developed as mentioned above by chemical engineers in the United States), or in those areas of process development which involve both engineering and chemical insight. Many German executives expressed the view that still too few people in the West German chemical industry possess a really rounded view of the process as a whole. This is particularly important in the continuous heavy organic or inorganic plant. It is here that the United States chemical engineer's training, particularly of advanced degree caliber, has provided some outstanding examples. Two are cited here:

a. The silver catalyst for direct oxidation of ethylene to ethylene oxide was found by a French chemist in 1930, and basically the chemistry and the catalyst have not changed since. But yields have been raised at least twenty points and the capital greatly lowered by the application of U. S. chemical engineering concepts *(12)*. The improved process has now been reintroduced to Europe and Asia from the United States.

b. Suspension polymerization of polyvinylchloride has been until recently operated only in large plants both in West Germany and in the United States. A chemical engineering analysis (aided by chemists) resulted in purely engineering design changes which in no way affected product quality but reduced the capital investment to half of what had previously been deemed possible, so that small plants for captive users became feasible *(13)*. No laboratory work at all was necessary in making these designs, but only a profound understanding of both the polymerization itself and the heat transfer and diffusion characteristics of the system.

These few examples suggest that it would be shortsighted to ignore the special contribution of the chemical engineer, particularly in view of his leading role in the great accomplishments of the American chemical industry, not only in economy, but in innovations *(14)*.

A criticism voiced in West Germany has been that there is insufficient mathematical skill in the West German training of both process engineers and chemists, and insufficient use of computers. As a result the viewpoint tends to be somewhat more qualitative and intuitive. Where the individual is able, this can result in remarkable discoveries. But for the average, a quantitative technique is surer, if less spectacular. In the United States, mathematical aspects of design are more prominent in modern chemical engineering training, contributing to the aforementioned over-all process perspective. Mathematicians are appearing increasingly as members of the team. In this same area the West German approach to applied chemical kinetics and thermodynamics still lies behind the United States level of quantitative chemical engineering treatment. There is substantial but not unanimous sentiment in West Germany for slightly greater chemical training in the process engineering curriculum, with more thermodynamics and kinetics and less machine design.

One difficulty shared by both nations' chemical industries is the necessity for secrecy. Where on-job training still is important, this secrecy may hinder the attainment of a rounded viewpoint.

Conclusions

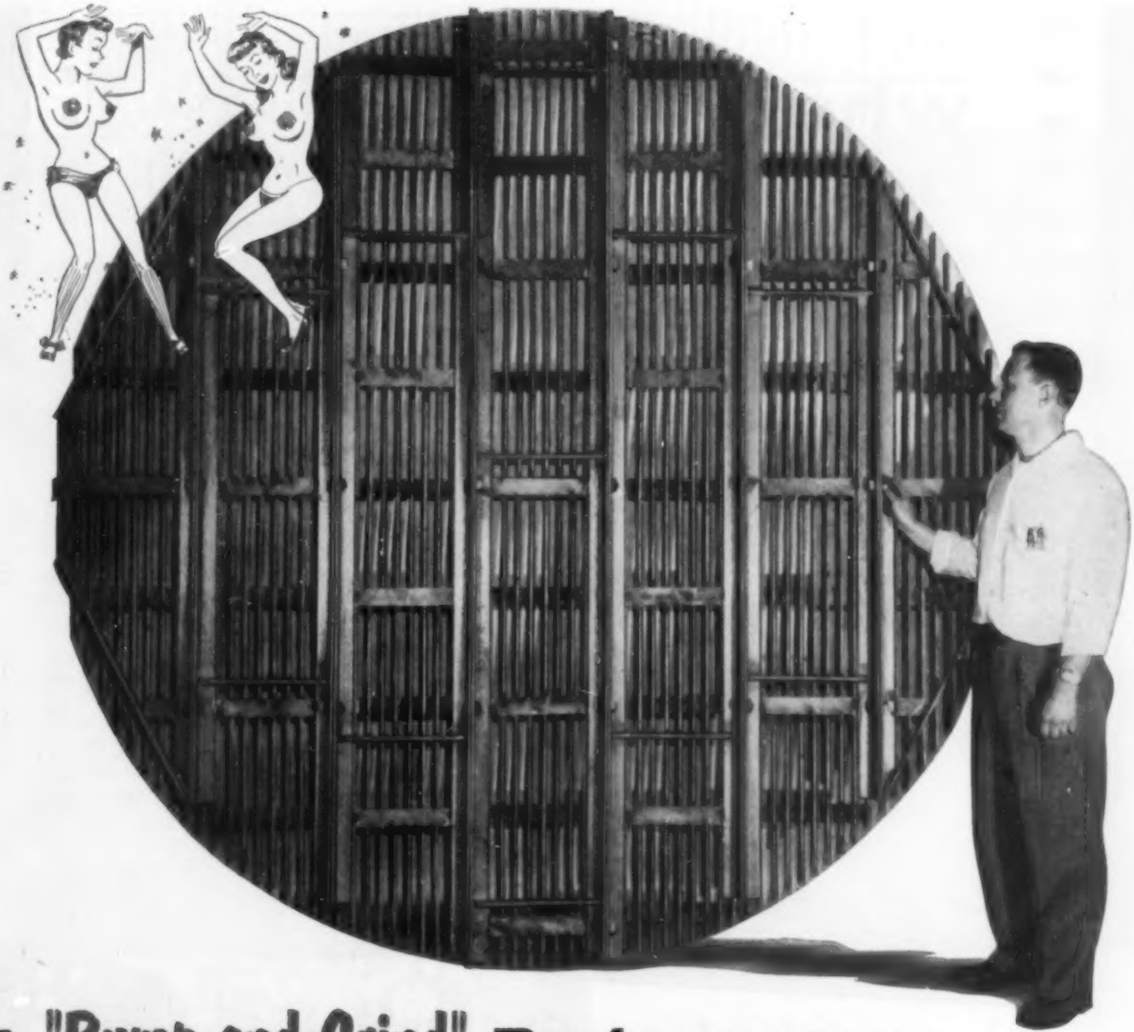
1. West German and American chemical industry conditions are sufficiently dissimilar to have evolved along divergent paths, but within ten to fifteen years there will be fewer differences, as the world chemical industry becomes less national and more universal in character.

2. The West German emphasis on compatibility of teams working together, surprising perhaps in a European country where people are generally more individualistic, is basically very much like that of the United States.

3. The West German approach of training a number of technological assistants without giving them college degrees is apparently sound.

4. The West German stress on science and fundamentals in educating chemists and engineers is valid. The high level of training of their chemists should be carefully noted; in fact, it is just possible that proportionally too few young men are studying graduate level chemistry in the United States today, and that perhaps too often semiroutine work is their industrial destiny. However, beyond the research stage lies a very broad area of application. To help fill it, perhaps both countries will evolve a new type of engineering science specialist with doctoral training who can

continued on page 115



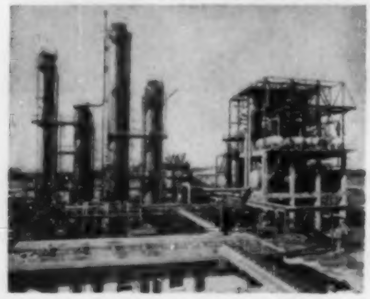
Ethylene oxide plant major Wyandotte unit

A new 60 million pound ethylene oxide-ethylene glycol plant is the first unit on-stream at Wyandotte Chemical Corp.'s big chemical manufacturing center at Geismar, La. Shell oxygen oxidation process is used in new plant.

Costing $11 million, Wyandotte's ethylene oxide plant is already operating at anticipated capacity (60 million pounds a year when full production is reached). The ethylene used comes from Esso's Baton Rouge refinery, the oxygen from a Linde unit which is part of the plant.

Despite the present recession, and estimates by other companies that indicate a tightened market for ethylene oxide, Wyandotte is convinced that its new plant will be economic, will sell its entire output. In fact, the output for 1958 and well into 1959 is already sold, according to Wyandotte.

Of main interest to chemical engineers are two facts about this unit: first, it is only one unit of Wyandotte's chemical center that will cost some $37 million when completed; second, the plant uses the oxygen oxidation of ethylene as opposed to processes in use by companies longer in the field.



Left, the ethylene oxide purification towers, and right, the reactor unit at Wyandotte's new plant.

Process

In the Shell process used by Wyandotte, ethylene is reacted with oxygen in the presence of a silver catalyst. The crude oxide is then stripped and purified, and either used as ethylene oxide or piped directly to the glycol unit where it undergoes hydration to form ethylene glycol.

As the oxide, the product is used by Wyandotte to produce specialty chemical derivatives such as the Pluronic and Tetronic polyols. A sizable part of the output of the new plant will be sold to other industries.

There is considerable debate in the field as to the merits of the Shell process, but Wyandotte is putting its faith in oxygen oxidation.

More to come

The ethylene oxide-ethylene glycol plant is the first of two major plants at Geismar. The first half of a 300-ton a day chlorine, and 330-ton a day caustic, plant is well under way, will be on-stream early in 1959 with the second half of the unit scheduled for later in 1959.

Cost of the chlorine-caustic plant will be $26 million, the process is electrolytic using 30,000 ampere rectangular diaphragm cells.

The two plants mark Wyandotte's first large investment outside Michigan, will be operated by the Michigan Alkali Division.

Process improvements change Carbide's ethylene oxide plans

Carbide is recasting its plans to expand production of ethylene oxide and ethanol. Reason: increased output of present facilities resulting from process improvements, and re-evaluation of future market estimates.

Major change in the plans of Union Carbide Chemicals for ethylene oxide and ethanol is the deferring of the company's petrochemical project at Putnam, W. Va. announced last year. Originally scheduled to be completed early in 1960, the new target date will probably be somewhere in 1962 or 1963. With the claimed process improvements in mind, Carbide is restudying engineering designs for the new unit, reappraising production and feedstock economics.

While details of process developments are not being divulged now, Carbide, which uses mainly an air oxidation process, reports that the improvements involve significant modifications in reaction conditions, as well as engineering changes. Result of these developments, Carbide says, is an already-made 60 million pound a year increase in ethylene oxide production capacity at existing domestic plants. The same improvements will be incorporated in the plants being built in Puerto Rico and England by companies affiliated with Carbide.

Throughput capacity at Carbide's Texas City ethanol plant has also been substantially increased, with total capacity up to 20 million gallons a year.

Markets, too

In Carbide's view, current business conditions have slowed consumer demand for ethylene oxide, its forecasts show a probable lag of a year before the characteristic growth rate curve is resumed. In addition, the output of Carbide's affiliated new units in England and Puerto Rico will be sold abroad, will cut into the market now serviced by domestic units.

At present, then, Carbide is holding back expansion plans for ethylene oxide, is upping capacity with improvements rather than new construction in this country.

Expanding market seen for polyvinyl alcohol

An expected upsurge in end uses for polyvinyl alcohol is behind Air Reduction's decision to construct a 20 million pound per year polyvinyl alcohol resin plant at Calvert City, Ky. Existing uses, for which substantial expansion is seen, are in the preparation of adhesives, textile sizing and finishing, paper coatings, and as emulsifying and thickening agents. A special form is employed as a starting material in the production of polyvinyl butral, which is the plastic interlayer for automobile safety glass.

Cost of the new unit, to be designed by Lummus for completion in early 1960, is estimated at $12 million. The project will include an expansion doubling the capacity of the existing 45 million pound vinyl acetate monomer plant completed at Calvert City in 1956; this was dictated by the fact that about two pounds of the monomer are required to make one pound of the polyvinyl alcohol resin.

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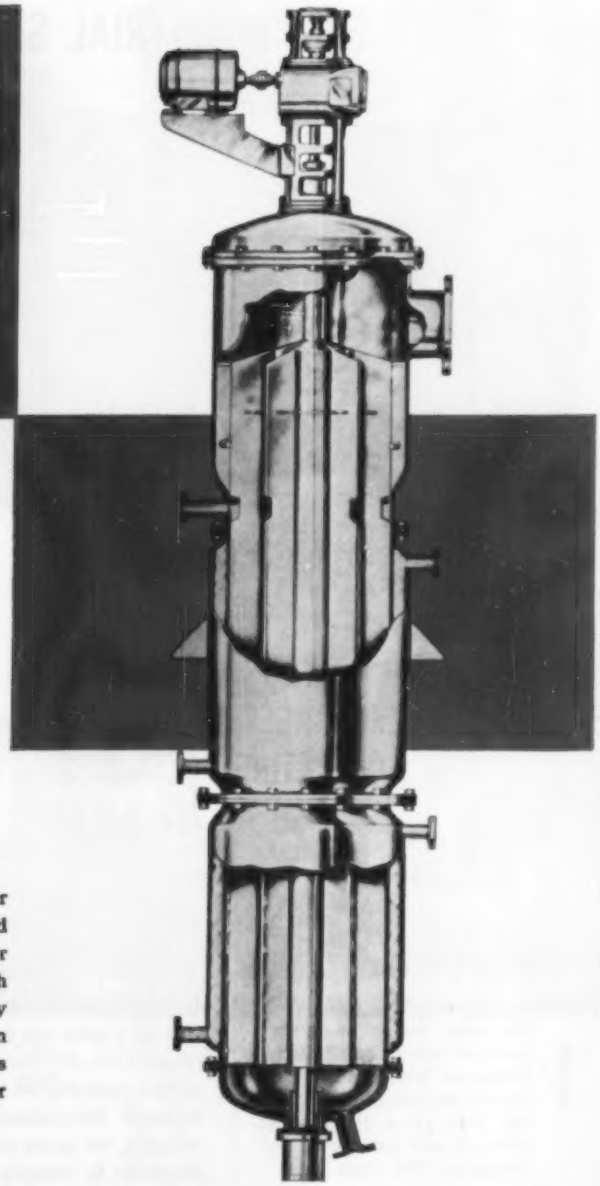
* *Vacu-Film is a trade name of the Rodney Hunt Machine Co. Prior to June 1, 1958, this unit was manufactured under the name "ASCO" Rota Film Still.*



THE RODNEY HUNT TURBA-FILM PROCESSOR
consists of a series of rotor blades operating within a thermal section and a separating section—all fabricated of alloy steel. Clearance between the rotor blade edges and the thermal section wall is exactly fixed to assure precise control of the film thickness. Vapor or gases pass upward through the thermal section to the separator from which entrained material is recycled to the thermal section. Steam, Dowtherm or other heating media is distributed in two or more compartments of the thermal section to assure a uniform temperature at the walls.

RODNEY HUNT

AND ENGINEERING

New facilities to spur product development, corrosion research

Two major research establishments are in the news this month: Atlas Powder's newly-dedicated Technical Center in Wilmington, Del.; and Carpenter Steel's new corrosion research laboratory in Reading, Pa.

"To guide new products or applications through the stages from the research laboratory to the salesman's catalog—and continuing customer service after the product is sold." Such is the avowed purpose of the Product Development Dept. in Atlas Powder's Wilmington Technical Center. Also at the same location are extensive new basic research facilities.

Special test apparatus and methods at Carpenter Steel's new Reading Laboratories are said to permit determination of corrosion rates on heat transfer equipment with extreme precision. The new apparatus can be used with all aqueous chemical solutions and with all types of heat exchangers operating at temperatures between 140° and 392° F. Particular importance will be attached to prediction of the behavior of alloys for heat exchangers in the atomic energy field.

Stress corrosion cracking in high temperatures is another first priority project at Reading, as well as concerted attacks on the problems of pitting, intergranular corrosion, and preferential attack on metals. A specially designed autoclave now permits evaluation of various metals and alloys at pressures up to 3,000 lb./sq. in. and temperatures to 750° F in a variety of corrodents; number one target in this work will be the testing of zirconium alloys for nuclear reactor applications.

An increase of 50 tons/day in production of concentrated nitric acid is announced by Hercules Powder. A new unit at the company's Parlin, N. J., plant will use magnesium nitrate as a desiccant instead of sulfuric acid to give a 99% concentrate in normal production compared to the 97% resulting from conventional methods. Contractor for the new Parlin unit was Badger Manufacturing Co.

TOWER PACKING

All the facts about HARSHAW *tellerettes*

Contained in this comprehensive booklet discussing the application of Harshaw Tellerettes to tower packing.

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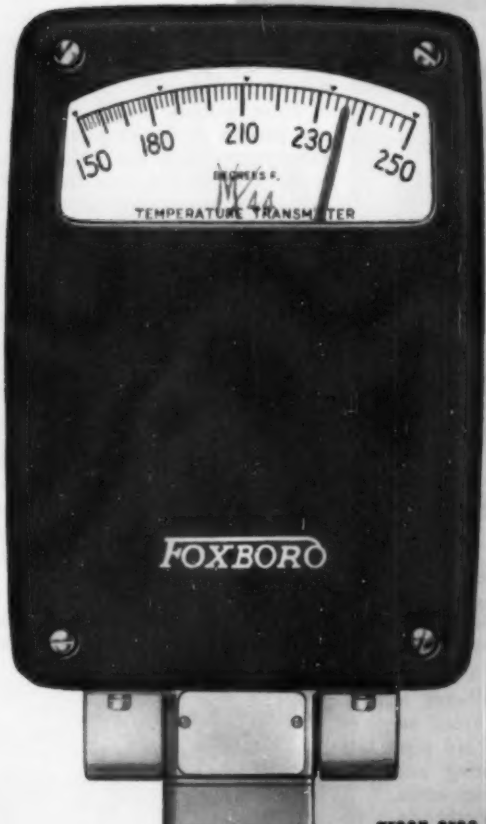

green area is actual size silhouette of the new M/44

Here's a brand new instrument engineered specifically for its job of indicating and transmitting temperature.

The M/44 Indicating Temperature Transmitter offers the inherent simplicity of a motion balance instrument. Compact and lightweight (10 lbs.) its indicating scale and fluorescent red pointer are visible up to 20 feet away. The output pressure of the M/44 is transmitted to any remote 3-15 psi recorder, controller, or indicator.

The M/44 is made with standard performance-proved Foxboro components, simply and conveniently arranged in a weather proof steel case. Changing range or type of thermal system can easily be done in your own plant.

Thanks to its rugged construction, the new M/44 is unaffected by vibration, sudden shock, or corrosive atmosphere. Even in the event of air supply failure, this instrument continues to indicate process temperature.

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Class IA & IB Liquid Expansion (−250° to +600° F)
Good response, good sensitivity, uniform scale. Uses smallest bulb of any filled thermal system.

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Applicable to ranges beyond the limits of other filled systems. Uniform scale. Bulb has long sensitive section; permits useful averaging measurements.

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TEMPERATURE MEASUREMENT AND CONTROL

Integration in Japan

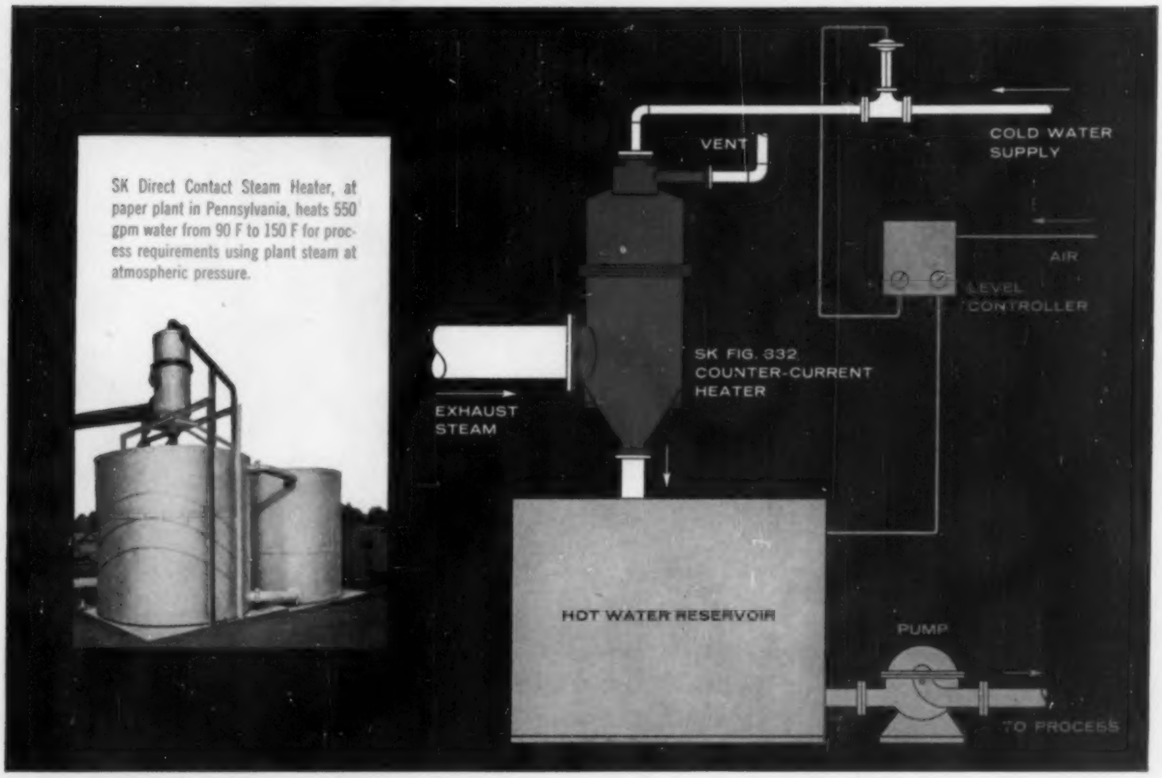
Japan's Mitsui Petrochemical Industries, Ltd. will combine two American processes to obtain para-xylene in high yield from ordinary mixed xylenes; American licensors are Standard Oil (Indiana) and Atlantic Refining.

The new plant, slated for completion at Iwakuni City in the summer of 1959, will use Standard's separation process to extract para-xylene of high purity from the mixed xylene feed. The effluent from the separation unit, consisting primarily of ortho-xylene, meta-xylene, and ethyl benzene, will be passed through an isomerization unit based on Atlantic's "Octafining" process, in which these isomers of para-xylene will be converted to pure para-xylene. The hydrocarbon stream from the isomerization unit will be continuously recycled back to the separation system.

The para-xylene product will be used in the manufacture of terephthalic acid, an important intermediate for synthetic textile fibers; this operation will be carried out in an oxidation unit also under construction at Iwakuni City.

Both the para-xylene plant and the oxidation unit are being designed and engineered by Scientific Design, New York.

Production is underway at the world's first offshore sulfur mining plant. The Y-shaped structure, nearly a mile long and rising 55 feet above the water, is the principle part of a $30 million Freeport Sulphur project to develop a major new sulfur deposit known as Grand Isle. The plant will use 13 million cubic feet of gas to heat 5 million gallons of seawater a day to 325°F for injection into the underground formation through wells.

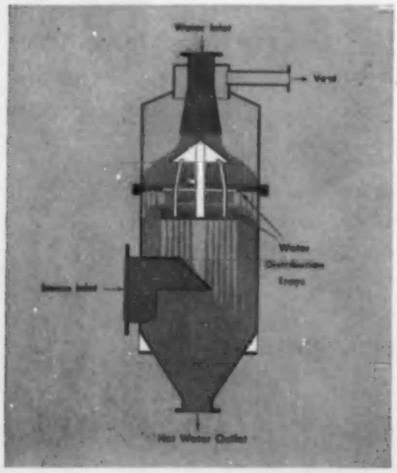


SK Direct Contact Steam Heater, at paper plant in Pennsylvania, heats 550 gpm water from 90 F to 150 F for process requirements using plant steam at atmospheric pressure.

FOR HOT WATER IN LARGE QUANTITIES

use SK Direct Contact Steam Heaters

Sectional drawing of SK Fig. 332
Direct Contact, High Capacity, Steam Heater



SK Direct Contact Steam Heaters are designed to provide large quantities of hot water, or other liquid, for plant or process use. They do this by using plant exhaust steam (at low pressure or at vacuum to 15 in. Hg) to heat the water which is then delivered to a tank or reservoir.

To users, these high capacity heaters offer specific, worthwhile advantages. They are simple in design, have no moving parts. Heating, by condensation of steam in the liquid, is very efficient, continuous, and fast. A temperature rise of 130 F is possible with most of these units. Semi-solids in the liquid are handled without difficulty. Costs are reasonable and the heaters require little maintenance. Capacity can be just about any reasonable amount desired, since capacity is determined by heater size and SK has not established any maximum. Although cast iron and fabricated steel are standard materials of construction, other special materials can be used when required.

The counter-current unit pictured above and at left is one of four types made by SK. This particular heater and all of the other types are described in detail in Bulletin 3A-HC which includes application information and data on sizes, dimensions, and capacities. Copies of Bulletin 3A-HC are available immediately on request. Send for a copy.

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ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
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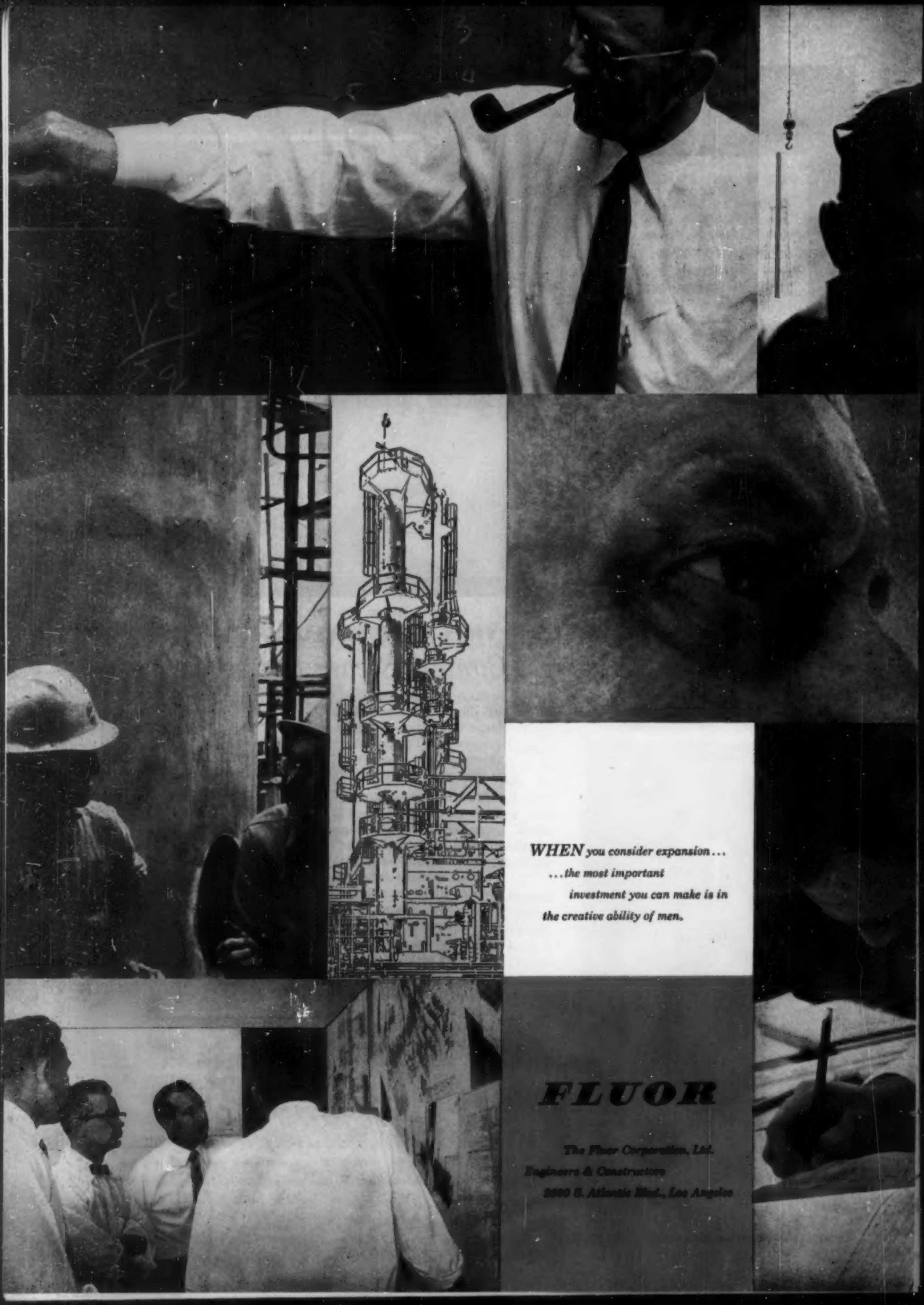
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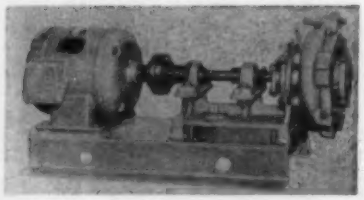

Developments of the month

PUMPS FOR ABUSIVE APPLICATIONS

Circle No. 395 on Data Post Card.

Nagle Pumps introduces a new line of centrifugal pumps specially designed for abusive applications, such as those involving abrasion, corrosion, or handling of hot liquids. They are available in three basic designs: type "KR" (shown) for limited heads, has end plate secured to housing by easily removable dogs; type "KC" for corrosive or mildly abrasive applications, where frequent inspection is not necessary, has a center-split casing, the two halves being bolted together; and type "KF", for high-pressure abrasive or corrosive applications, has the end plate secured to the housing by means of flanges and bolts. A bulletin is available giving complete data, including dimensions of 35 of the more than 60 size combinations. For a copy, circle Number 395 on Data Post Card.

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SUBJECT GUIDE to advertised products and services

EQUIPMENT

Agitators, side-drive. New England Tank & Tower Co. Bulletin 532 describes models from 1/3 to 30 hp. **Circle 100L.**

Air Engineering Equipment. Niagara Blower Co. Bulletin 135 describes heat exchangers, after coolers, condensers. **Circle 106TL.**

Bellows, Teflon. John L. Dore Co. Deflection charts furnished with each model. **Circle 19R.**

Belts, woven-wire. Cambridge Wire Cloth Co. 130-page reference manual. **Circle 105R.**

Burst Discs, graphite. Kearney Industries, Delanium Graphite Div. Technical data, price schedule. **Circle 108BL.**

Castings, Kutztown Foundry & Machine Co. **Circle 114TR.**

Coils, heating and cooling. Dean Products Inc. Bulletin 355 describes Thermo-Panel coil. **Circle 139BR-A.** Bulletin 258 gives design and price data. **Circle 139BR-B.**

Coils, fin-type. Rempe Co. Technical data. **Circle 132BL.**

Compressors, air. Cooper/Bessemer. Bulletin M-81 describes models from 200 to 10,000 hp. **Circle 104A.**

Condensers, barometic. Graham Mfg. Co. **Circle 80L-A.**

Condensers, direct-contact. Graham Mfg. Co. **Circle 80L-B.**

Condensers, vapor, air-cooled. Niagara Blower Co. Bulletin 129R gives full technical details. **Circle 116BL.**

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Crystallizers. Struthers Wells Corp. For quality, uniformity, purity. Bulletin CE-57. **Circle 21A.**

Dryers, "Rota-Cone". Paul O. Abbe. Capacities 1 to 500 cu. ft. Brochure C. **Circle 94L.**

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Filters, atomic wastes. Eimco Corp. **Circle 30A.**

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Flakers, Goslin-Birmingham Mfg. Co. **Circle 92L.**

Generators, inert gas. John Zink. **Circle 133L-B.**

Glassed-steel Equipment, Pfaudler Co. Bulletin 968 (Buyers Guide) gives details on full line. **Circle 28-29A.**

Heat Transfer Equipment. Allis-Chalmers. Technical details on all types. Bulletin 25C6177. **Circle 23A.**

Heat Transfer Equipment, M. W. Kellogg Co. **Circle 91A.**

Heat Transfer Equipment. Doyle & Roth Mfg. Co. Custom engineered. **Circle 115R.**

Heat Exchangers, graphite. National Carbon Co. **Circle 13A-A.**

Heat Exchangers, plate-type. American Heat Reclaiming Corp. Operating pressures to 175 lb./sq. in. Technical data. **Circle 76L.**

Heaters, air. John Zink Co. Outlet temperatures from 200 to 3,000°F. **Circle 133L-A.**

Heaters, air-fired. Thermal Research & Engineering Corp. Technical information in Bulletin 105B. **Circle 127R.**

Heaters, plate, graphite. National Carbon Co. High transfer rates, no corrosion. **Circle 13A-C.**

Heaters, steam, direct-contact. Schutte and Koerting Co. Bulletin 3A-HC. **Circle 81A.**

Indicators, flow. Schutte and Koerting Co. Complete details. **Circle 132BR-B.**

Joints, expansion. Adsco Div., Yuba Consolidated Industries. Technical data. **Circle 93A.**

Joints, flexible, ball. Barco Mfg. Co. Detailed information in Catalog 215B. **Circle 129R.**

Laboratory Equipment. Metalab Equipment Co. 180-page Catalog 5B. **Circle 112TL.**

Laboratory Equipment, fused quartz. Thermal American Fused Quartz Co. Technical data. **Circle 125L.**

Mixers, all types. Mixing Equipment Co. Bulletin 109 (condensed catalog). **Circle OBC-F.**

Mixers, laboratory, small batch. Mixing

continued on page 88

Numbers followed by letters refer to equipment, materials, and services advertised in this issue. Numbers indicate pages, and letters positon on the page: L, left; R, right; T, top; B, bottom. A indicates full page; IFC, IBC, and OBC are cover advertisements.

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114BR	115R	116TL	116BL	118L	125L	125R	126B	127R	
128TL	128BL	129R	130L	130R	131BL	131R	132BL		
132BR	133L-A	133L-B	133R	138TL	138ML	138BL	139TR		
139BR	IBC	OBC-A	OBC-B	OBC-C	OBC-D	OBC-E	OBC-F		

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CEP's DATA SERVICE—Subject guide to advertised products and services

continued from page 84

Equipment Co. Bulletin 112. **Circle OBC-E.**

Mixers, portable. 1/8 to 3 hp. Mixing Equipment Co. Bulletin 108. **Circle OBC-C.**

Mixers, side-entering. 1 to 25 hp. Bulletin 104. **Circle OBC-D.**

Mixers, top-entering, propeller types. 1/4 to 3 hp. Mixing Equipment Co. Bulletin 103. **Circle OBC-B.**

Mixers, top or bottom entering, turbine, paddle, and propeller types. 1 to 500 hp. Mixing Equipment Co. Bulletin 102. **Circle OBC-A.**

Nozzles, spray. Spray Engineering Co. Technical information. **Circle 109R.**

Nozzles, spray. Binks Mfg. Co. Complete catalog. **Circle 131BL.**

Packers, mechanical. B. F. Gump Co. Details in Bulletin 401. **Circle 3R.**

Piping, alloy, large-diameter. Posey Iron Works. Complete information. **Circle 126B.**

Plates, hold-down, for packed towers. U. S. Stoneware. Bulletin HDP-56. **Circle 69A.**

Potentiometer, recording, miniature. Westronics, Inc. **Circle 70A.**

Presses, de-watering. E. D. Jones & Sons. Technical data. **Circle 114L.**

Presses, filter, plastic. T. Shriver & Co. Technical details. **Circle 128TL.**

Processor, vacuum-film. Rodney Hunt Machine Co. Technical data. **Circle 74-75A.**

Pumps. Peerless Pump Div., Food Machinery and Chemical Corp. Bulletin EM-79 (Mechanical Considerations in Pump Design). **Circle 22A.**

Pumps. Aldrich Pump Co. Technical data. **Circle 87A.**

Pumps, centrifugal. Frederick Iron and Steel, Inc. Bulletin 107. **Circle 131R.**

Pumps, centrifugal, corrosion-resistant. Bart Mfg. Corp. Catalog and performance curves. **Circle 138TL.**

Pumps, controlled volume. Lapp Insulator Co. Bulletin 440 with applications, flow charts, specifications. **Circle 73A.**

Pumps, graphite, National Carbon Co. for handling individual and mixed acids. **Circle 13A-B.**

Pumps, leakproof. Chempump Corp. Temperatures to 1,000°F. pressures to 5,000 lb./sq. in. Technical data. **Circle 10A.**

Rectifiers, mercury-arc. Allis-Chalmers. Detailed information. Bulletin 12B8494. **Circle 78A.**

Rotameters. Schutte and Koerting Co. Complete details in Bulletin 18B. **Circle 132BR-A.**

Safety Heads. Black, Sivalls & Bryson, Inc. Technical data. **Circle 8L.**

Screens. Allis-Chalmers. Separations from 12 in. to 325 mesh. Bulletin 26C6177M (selection guide). **Circle 7A.**

Scrubbers, fume, jet-venturi. Croll-Reynolds Co. Complete catalog. **Circle 34A.**

Separators, entrainment. Otto H. York Co. Data on Yorkmesh Demisters. **Circle 4A.**

Storage Units, liquid oxygen and nitrogen. Hofmann Laboratories. **Circle 128BL.**

Transmitter, temperature, indicating. Foxboro Co. Bulletin 13-28A. **Circle 79A.**

Valves. Wm. Powell Co. Technical data. **Circle 89A.**

Vessels, storage, corrosion-resistant. Ellicott Fabricators, Inc. **Circle 107R.**

Vibrators, bulk material flow. Bin-Dicator Co. Technical data. **Circle 114BR.**

Viscometers. Brookfield Engineering Laboratories, Inc. Complete technical information. **Circle 102L.**

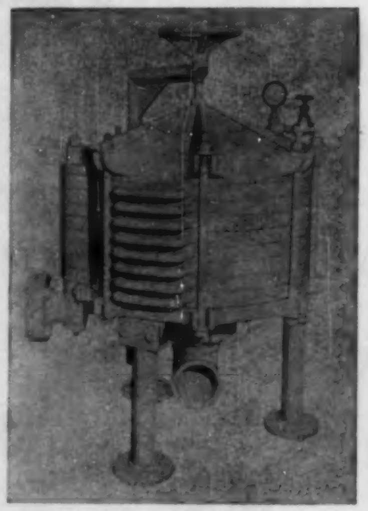
Water Supply Systems. Layne & Bowler, Inc. Bulletin 100. **Circle 11A.**

Waste Disposal Systems. Dempster Brothers. Booklet, "How to Cut Waste Disposal Costs." **Circle 6A.**

MATERIALS

Borohydrides, sodium and potassium. Technical data. Metal Hydrides, Inc. **Circle 101A.**

Developments of the month



TANKLESS HORIZONTAL PLATE FILTER

Circle No. 396 on Data Post Card.

Eliminates the necessity of a tank by having the filter plates serve as a filter unit within themselves. Several measures have been taken to eliminate leakage: clamping with tie-rods as opposed to single bolt clamping on rectangular plates; plastic impregnated edges on cloth and other media; construction designed to withstand 150 lb. pressure without leakage through sealing edges. There is no unfiltered heel at the end of the cycle and the filter cake can be blown dry by means of gas or air pressure.

The unit is available from Sparkler Manufacturing Co. in mild steel, stainless steel, and aluminum, in capacities up to 396 sq. ft. of filtering area. Standard operating pressure is 150 lb. For details, circle Number 396 on Data Post Card.

Coatings, silicone. Midland Industrial Finishes Co. **Circle 133R.**

Filter Cloth, metallic. Newark Wire Cloth Co. Catalog E. **Circle 12L.**

Heat Transfer Medium. Thermon Mfg. Co. Technical data. **Circle 130L.**

Linings, fluorocarbon plastic. United States Gasket Co. Bulletin AD-152. **Circle 26L.**

Packing, reinforced Teflon. Flexrock Co. Technical brochure. **Circle 139TR.**

Packing, tower. Harshaw Chemical Co. Booklet on Tellerettes. **Circle 77A.**

Packing, tower, porcelain. Knox Porcelain Corp. **Circle 108TL.**

Plastics, sheets, rods, tubes. Kaufman Glass Co. Catalog and price list. **Circle 112BL.**

Resins, ion-exchange. Illinois Water Treatment Co. Technical data sheet. **Circle 125R.**

Steel, stainless. International Nickel Co. Booklet on corrosion resistance. **Circle 95A.**

Tantalum Test Kit. Fansteel Metallurgical Corp., Chemical Equipment Div. **Circle 18L.**

Wire, thermocouple extension. Claud S. Gordon Co. Bulletin 1200-3. **Circle 130R.**

SERVICES

Design and Construction, plants. Fluor Corp. **Circle 82A.**

Design and Construction, plants, Foster Wheeler. **Circle 103A.**

Design and Construction, plants. C. W. Nofsinger Co. **Circle 138BL.**

Design and Construction, hydrogen-carbon monoxide plants, Girdler Construction Div., Chemetron Corp. **Circle 71A.**

Design and Construction, oxygen plants. Air Products, Inc. **Circle 32A.**

Fabrication, process equipment. Wyatt Metal & Boiler Works, Inc. **Circle IFC.**

Fabrication, process equipment. Downingtown Iron Works, Bulletins. **Circle 27R.**

Fabrication, process equipment. Manning & Lewis Engineering Co. **Circle 96L.**

Fabrication, process equipment. Edw. Renneburg & Sons. Technical information. **Circle 113R.**

Fabrication, process equipment. Koven Fabricators, Inc. Bulletin 550. **Circle 118L.**

Fabrication, process equipment, aluminum, special alloys. Vulcan Mfg. **Circle 24-25A.**

MISCELLANEOUS

Automobiles, Oldsmobile Div. General Motors. **Circle 9A.**

Heat Transfer, Fluid Mechanics Papers. Stanford University Press. **Circle 138-ML.**

Equipment

305 Liquid Feeder Bulletin. Clarkson Co. offers bulletin on its feeder Model E in PVC for controlled feeding of acids and other corrosive liquids. Performance and design data.

306 Pedestal Type Centrifugal Pumps. Capacities from 10 to 80 gal./min. against heads to 70 ft., self-enclosed impellers, self-adjusting seals. Data from Bart Mfg. Corp.

307 Continuous Pipeline Mixer. New Model "S" Homomix, made by American Well Works, assures low-cost continuous pipeline mixing. Technical data.

308 Top-Entering Mixers. Technical bulletin from Specialty Engineers Co.

309 Data Sheet on Continuous Titrator. Can be coupled with instrumentation for complete automatic process control. Data sheet gives specifications and schematic diagrams. Milton Roy Co.

310 Large Size Start-up Strainers. In 6 to 16 in. steel construction with 150 or 300 lb. flanges. Data from Leslie Co.

311 Silicone Rubber Insulated Cables. Comprehensive book from National Electric Products Corp. gives special properties, selection data.

312 New Pump-Motor Unit. For circulation and transfer of corrosives. Capacities to 16 gal./min. Specifications, performance chart, dimensional drawings, construction data from Goulds Pumps.

314 Liquid Level Control Systems. Designed by U.S. Electrical Motors, new system consists of Varidrive motor equipped with pneumatic Varitrol actuator. Bulletins.

315 Processing Equipment Catalog. Describes hammer mills, double and single disc attrition mills, single and double roll crushers and magnetic separators. Bauer Bros. Co.

316 Underwriters' Approved Fire Pumps. Thirty-two-page bulletin from Peerless Pump Division, Food Machinery and Chemical Corp., gives details of single stage, horizontal multi-stage, and vertical turbine multi-stage types.

317 Process Equipment Brochures. Bulletins on heat exchangers, tank transports, liquid coolers, pilot plant equipment from Doyle & Roth Mfg. Co.

318 Nickel-Coated Lubricated Plug Valves. Same corrosion resistance as solid nickel or stainless valves, improved mechanical and physical properties. Information from Rockwell Mfg. Co.

319 Booklet on Water Treatment Equipment. Manual from Permutit Co. gives details of aerators, degasifiers, deaerators, chemical feeders, precipitation equipment, filters, ion exchange equipment, treatment systems.

320 Teflon-Lined Pipe and Fittings. Chemically-inert, corrosion-proof, has the strength of steel. Bulletin from Resistoflex Corp.

321 Indicating-Controlling Pyrometer. Bulletin from Illinois Testing Laboratories on the Pyrotroller gives wiring diagrams, specifications, ordering instructions.

322 Data on Forged Steel Valves. Dimensions, material specifications, pressure-temperature ratings. Bulletin from R-P&C Valve Div., American Chain & Cable Co.

323 Rotary Regenerative Heat Exchangers. Air-to-air units can handle waste gases at temperatures to 1,000°F, flows up to 2,600 cu. ft./min. Efficiencies of 90% or more. Data from Air Preheater Corp.

325 Portable Flowmeter Calibration Unit. For all types of flowmeters, including variable area, turbine, positive displacement, and orifice meters. Complete information from Fischer & Porter.

326 Enclosed Pancake Motors. Reduce motor length up to 60% over standard motors. Bulletin from Louis Allis Co.

327 High Pressure Rotary Feeder Valves. Design and constructions features, engineering drawing with nomenclature and dimensions, table of specifications, in bulletin from Sprout, Waldron & Co.

328 Jacketed Conical Vacuum Dryer. New model, made by J. P. Devine Mfg. Co., gives improved results in drying of heat-sensitive materials which may be gently tumbled. Technical data.

329 Particle Sampler. The Konisampler, made by Joseph B. Ficklen III, is designed for collection of specimens for microscopic examination, air pollution surveys, monitoring level of dust, pollen or viruses. Technical data.

330 Teflon, Raylon, Kel-F Products Catalog. Raybestos-Manhattan offers 32-page catalog with complete specifications of sheets, rods, tubes, and tapes.

331 Pipeline Flow Indicators. Bulletin from Schutte and Koerting gives sizes, materials of construction, minimum flows, pressure and temperature ratings.

continued on page 90

Materials

363 Alumina Ceramics. Bulletin from Coors Porcelain Co. gives mechanical and electrical properties on their AD-99 ceramic, a dense, non-porous, 99.0% aluminum oxide.

365 Brochure on Isobutyl Acetate. Describes use in lacquer solvent systems. Gives comparisons with other principal medium-boiling solvents. Chart shows effect of solvents on solution viscosities of formulations. Eastman Chemical Products, Inc.

366 Hydrides for Pesticide Chemistry. Technical service report from Metal Hydrides, Inc. gives reactions used in manufacture of pesticides, solvent used, principal applications.

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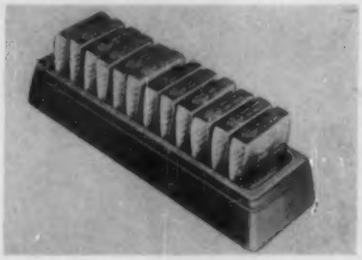
DEVELOPMENTS OF THE MONTH



EXPERIMENTER'S THERMISTOR KIT

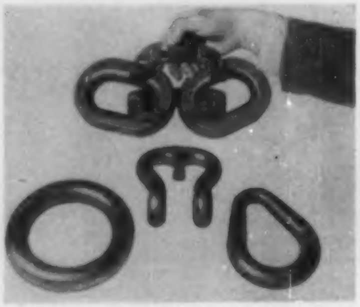
Circle No. 397 on Data Post Card.

Twelve representative thermistors, with complete curves and specifications for each, are included in a new experimenter's Thermistor Kit offered by Fenwal Electronics, Inc. The kit is designed to assist engineers in familiarizing themselves with thermistors, and for experimental work.

The kit contains two glass thermistor probes, three beads, two discs, three rods, and two washers. Accompanying data includes resistance-temperature and voltage-current curves, resistance values at various temperature points, maximum safe continuous temperatures, maximum current for no self heating, peak voltages, and maximum safe continuous currents. Additional specifications include "Alpha" at 25°C, ratio of resistance from 0°C to 50°C, and time and dissipation constants.

Cost of the kit is $19.95. A free catalog sheet describing them may be obtained by circling Number 397 on Data Post Card.

DEVELOPMENTS OF THE MONTH



NEW DESIGN KILN CHAIN

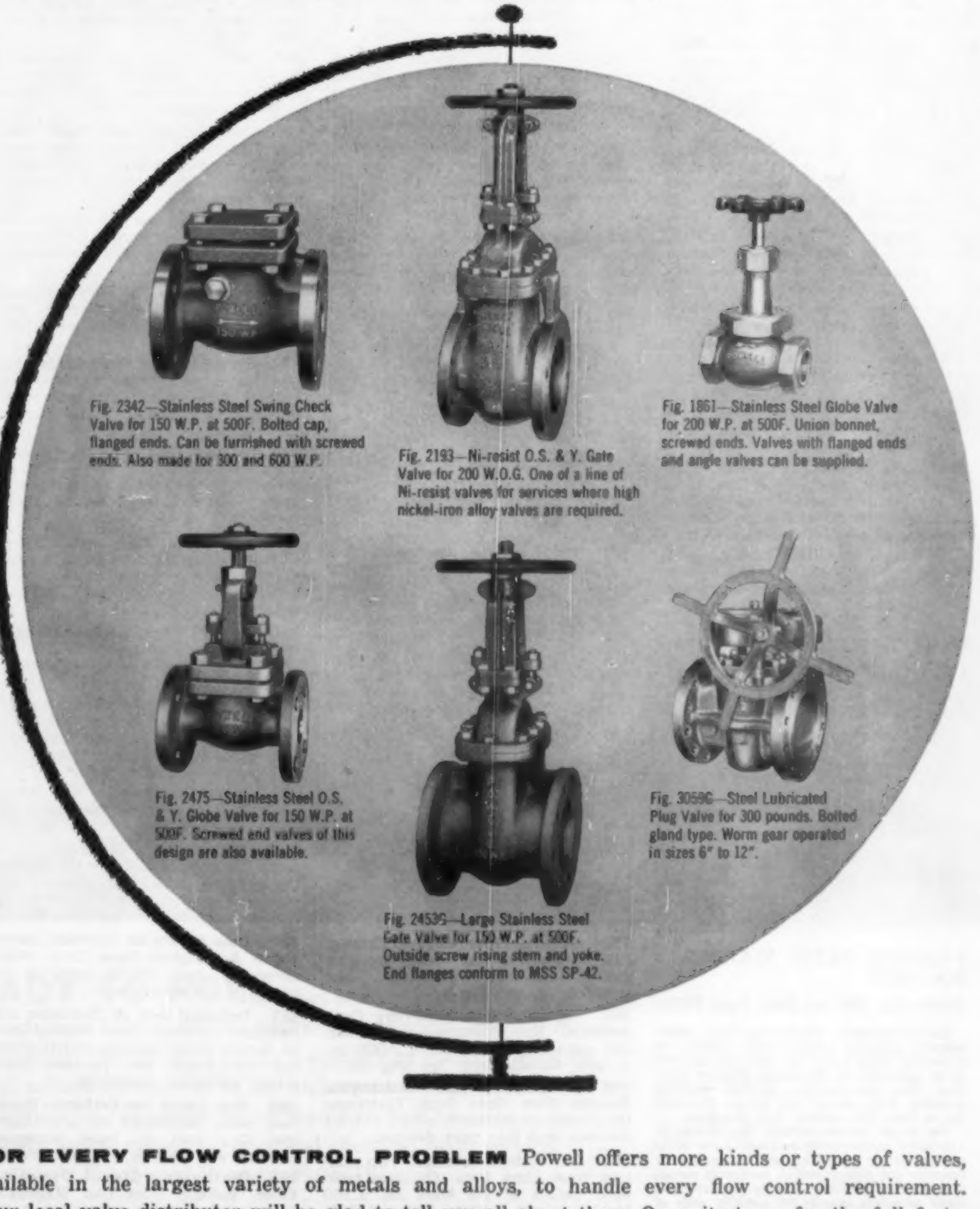
Circle No. 398 on Data Post Card.

A new type of kiln chain, developed by Allis-Chalmers, is said to reduce operating and maintenance costs in applications to wet process cement kilns, lime sludge kilns, and wash mills. The specially-designed link shape provides one-third more heat transfer surface than conventional chains, according te the manufacturer. Increased cross-sectional area also provides greater wear resistance with larger open link areas, allowing maximum flow at the feed end of the kiln and increased heat transfer efficiency throughout the chain system.

The chain is available by the link or in lengths, complete with end links, to meet specific chain system requirements. For technical details, circle Number 398 on Data Post Card.

POWELL

world's largest family of valves



FOR EVERY FLOW CONTROL PROBLEM Powell offers more kinds or types of valves, available in the largest variety of metals and alloys, to handle every flow control requirement. Your local valve distributor will be glad to tell you all about them. Or write to us for the full facts.

THE WM. POWELL COMPANY • *Dependable Valves Since 1846* • **Cincinnati 22, Ohio**

CEP's DATA SERVICE

Equipment *from page 88*

332 Motion Indicator. The Roto-Guard, made by Bin-Dicator Co., gives positive indication of drop in speed or stopping of machinery, by converting motion into signal which can energize an alarm or operate conrtol switches automatically. Bulletin.

333 Steam Turbine-Generator Bulletin. Allis-Chalmers offer new 40-page bulletin with design and construction features of steam turbine-generating units rated from 2,000 through 16,500 kw.

334 Data on Metallic Sealing Rings. Description of the four major types of sealing rings plus a four-page specification table. Koppers Co., Metal Products Division.

335 Vertical Pressure Filter Bulletin. Bulletin from Enzinger Div., Duriron Co., gives design data in tabular form, filtration cycle diagrams.

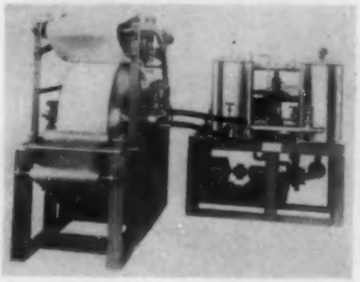
336 Powder Densifying Equipment. Bulletin from J. M. Huber Corp., describes new method and apparatus for deaerating and compacting, or densifying fine powdered materials.

337 Spray Drying Process Brochure. Describes latest parallel-flow spray dryer installations and research facilities. Swenson Evaporator Co.

338 Vacuum Valve Data Sheet. Gives specifications of 2, 3, 4, and 6 in. valves in both manual and air-operated types; 8 in. and larger sizes in air-operated only. F. J. Stokes Corp.

339 Liquid Level and Tank Contents Meters. Technical information from Uehling Instrument Co. on 100 standard models.

DEVELOPMENTS OF THE MONTH



PACKAGED FILTER STATIONS FOR RENT

Circle No. 399 on Data Post Card.

Komline-Sanderson Engineering Corp. offers complete packaged universal filter stations on a monthly rental basis. The units are designed to be applicable to all vacuum filtering problems. They are supplied complete with all accessory tanks, pumps, and motors. Construction is Type 316 stainless steel throughout.

The rental contract includes the services of a technical representative to assist in the initial start-up of the equipment, and instructions for operation and maintenance. A substantial portion of the rental payments can be applied as a credit allowance against the purchase price of plant-size, custom-built or standard filters.

For more details on this piloting service, circle Number 399 on Data Post Card.

340 Rotary Booster Bulletin. Increased capacity without increasing total connected horsepower. Data from Freezing Equipment Sales, Inc.

341 Selection Data on Stainless Tubing. Industry tolerance tables on diameter, ovality, wall thickness, straightness, length, and machining allowances for both seamless and welded stainless steel mechanical tubing. Bulletin from Babcock & Wilcox.

342 Bellows Flow Meter Catalog. New 20-page catalog from Minneapolis-Honeywell Regulator Co. covers features, specifications, applications. Full details on two basic models.

343 New Design Rotary Compressors. For continuous, heavy-duty industrial service handling air, gas, or vapor. Details from Fairbanks, Morse & Co.

344 Catalog on Flexible Ball Joints. Specially designed for handling liquid oxygen and high-energy fuels. Barco Mfg. Co.

345 Brochure on Particle Accelerators. Condensed specifications for entire line of accelerators made by High Voltage Engineering Corp.

346 Vapor Condenser. Capacity curves, table of dimensions and weights, may diagrams. Bulletin from Niagara Blower Co.

347 Chemical Feed Units. Bulletins from Neptune Pump Mfg. Co. describe units consisting of tank, agitator, and pump. Simplex, duplex, or dual operation.

348 New Indicating Controller. Low-cost unit provides two-position control and wide band proportional with or without automatic reset or rate action. Technical data. U. S. Gauge Div., American Machine and Metals, Inc.

349 Waste Heat Boiler Bulletin. Brochure from Struthers Wells gives details of six types of waste heat boilers and unfired steam generators.

350 Multiple Swivel Pneumatic Atomizing Nozzle. Has two or more swivel heads for multiple directional spraying. Technical information from Spraying Systems Co.

351 New Blower Design. Bulletin from Roots-Connersville Blower describes new design featuring a vertical arrangement of impellers to provide horizontal inlet and discharge connections for more convenient piping.

352 Miniature Thermocouple Catalog. Full details on four basic designs: gasket, bayonet, protected, and shielded. Thermo Electric Co.

353 High Pressure Stationery Compressors. Specifications on models with capacities from 368 to 2,000 cu. ft./min. Bulletin from Joy Mfg. Co.

354 Standardized Heat Exchangers. Bulletin from Ross Heat Exchanger Div., American-Standard, describes one-two, and four pass designs.

355 Gas Turbine Catalogs. Two catalogs from Clark Bros. Co. give technical details of the Mark TA, 1,150 bhp unit, and models 302 and 305, 8,700 to 9,300 bhp.

continued on page 92

Materials *from page 88*

367 Technical Data on Cast Stainless Steel. Folder from Cooper Alloy Corp., Foundry Products Div., lists 29 heat and corrosion-resistant alloys.

368 Information Sheet on Instant Antifoams. Tells how to use, what quantity, gives general theory behind use. Free samples also available. Hodag Chemical Corp.

369 Data on Colloidal Dispersions. Booklet from Acheson Colloids Co. describes applications, lists technical bulletins available.

370 Data on Corrosion-Proof Coatings. Bulletin from Atlas Mineral Products Co. gives properties and applications of their five standard corrosion-proof cements.

371 Stainless Steel Sheets and Plates. Chemical analyses, finishes, mill limitation chart. Eastern Stainless Steel Corp.

372 Applications of Vinlpyrrolidone. Twenty-five-page brochure with technical tables and charts. Antara Chemicals.

373 Heat-Resistant Phenolic Molding Powders. General characteristics, properties, applications. Brochure from Chemical Materials Dept., General Electric.

374 Industrial Chemicals. Folder from Virginia-Carolina Chemical Corp. shows properties and applications of wide line of basic chemicals and intermediates.

375 New Nylon Compound. Barrett Division, Allied Chemical Corp., announces a new nylon compound for extrusion of large shapes. Technical data.

376 Bulletin on Anhydrous Ammonia. New technical bulletin from Sun Oil Co. on commercial and refrigeration grades.

377 Chemical Intermediates. Booklet from Naugatuck Chemical Div., U. S. Rubber Co., gives physical and chemical properties of 18 intermediates, lists suggested applications.

378 Technical Bulletin on Methyl Chloride. Physical and chemical properties, specifications, toxicity, applications. Ansul Chemical Co.

379 Data on Industrial Insulations. Thermal, mechanical and physical, and chemical characteristics presented in new catalog from Baldwin-Hill Co.

380 Data Sheets on Stainless Steels. Jones & Laughlin Steel Corp. offers series of data sheets covering 17 types of stainless steels.

381 Technical Data on Zirconium and Hafnium. Brochure from Mallory-Sharon Metals Corp. contains charts showing mechanical and physical properties, corrosion resistance.

382 New Cation Ion Exchange Resin. New resin, developed by Dow Chemical Co., said to have increased strength and stability. Technical data.

383 Diethylene Glycol Dimethyl Ether. Bulletin from Olin Mathieson Chemical Corp. gives properties, applications.

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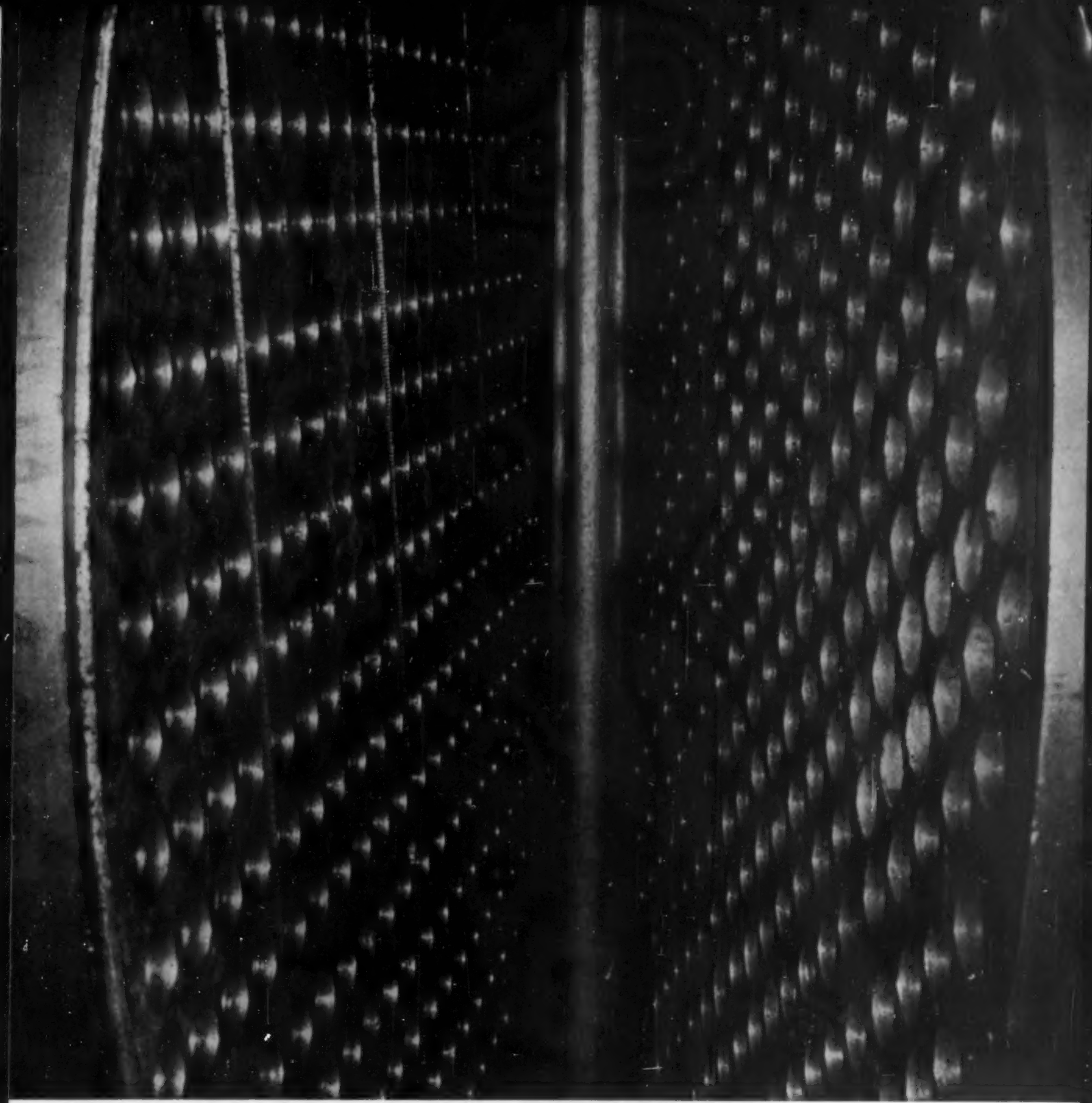


CEP's DATA SERVICE

Equipment *from page 90*

356 Packless Valves for High Temperature. Specially-designed for radioactive material in form of corrosive fused salts or liquid metals. Four-page bulletin from Hoke, Inc.

357 Liquid and Gas Meters. Brochure from Builders-Providence, Inc., describes the Propeloflo for liquids, and the Shuntflo for air, steam, or gas.

358 Nuclear Instrument Catalog. General descriptions and basic specifications of instruments for research and industrial control of nuclear work. Hamner Electronics Co.

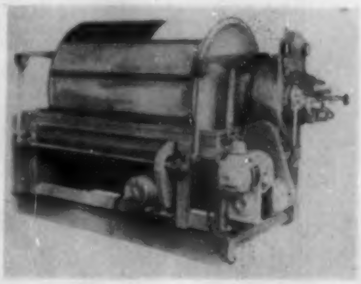
359 Brochure on Mills and Homogenizers. Describes more than 100 sizes and types of particle size reduction equipment. Tri-Homo Corp.

360 Graphite Rupture Discs. Data sheet from Carbone Corp. gives dimensions and ratings.

361 Catalog on Remote Controls. Trimount Instrument Co. offers technical data on Crown Hydra-Trol remote controls. Full descriptions and specifications.

362 Automatic Valve Actuating Conversion Unit. New catalog gives design, maximum pressure differential data, and cross-section diagram. C. H. Wheeler Mfg. Co.

DEVELOPMENTS OF THE MONTH

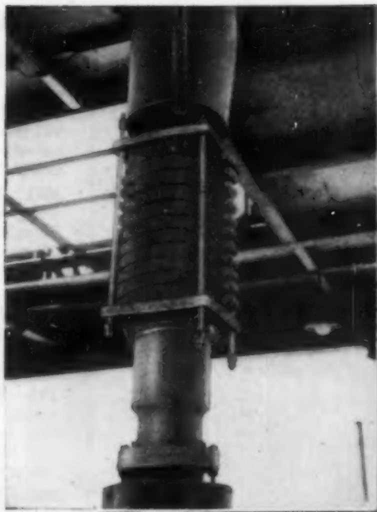


FIRST COMMERCIAL PLASTIC FILTER

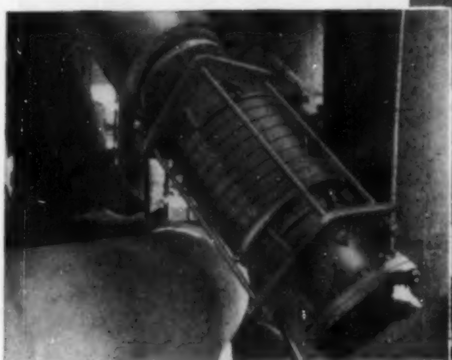
Circle No. 400 on Data Post Card.

Developed specifically for mildly corrosive applications which normally require special materials of construction, this unit is said to cost less than rubber-covered or stainless machines of comparable size and design. A prototype has been successfully tested at a uranium mill in the Western U.S., where it was used to separate leach residues from acid leach solutions. Continuous operation is possible at temperatures up to 170°F.

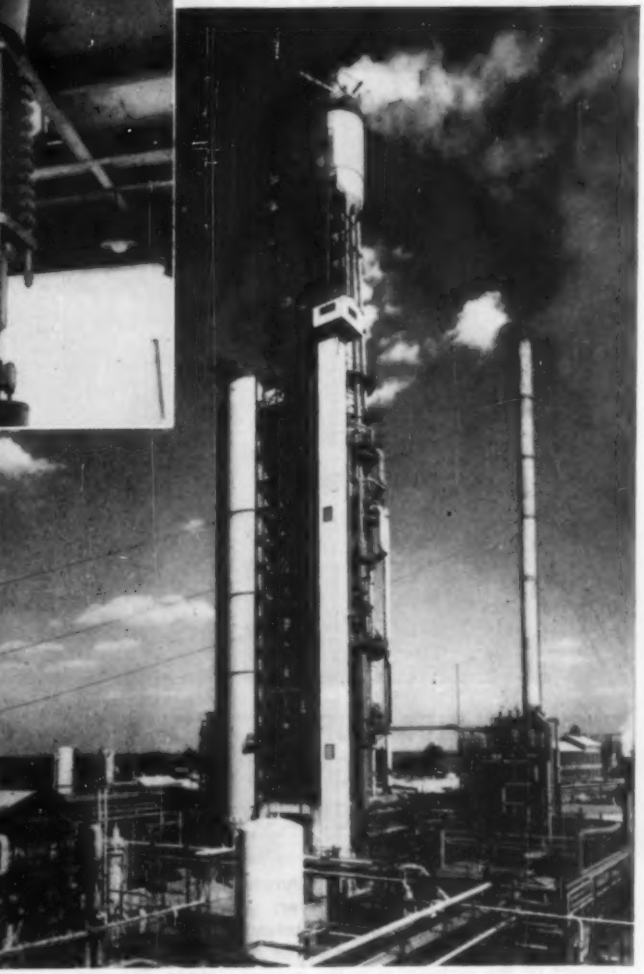
Components of the filter are fabricated of molded plastic with certain supporting structural members of resin-coated mild steel. The Fiberglas drum with molded plastic trunnion and drum heads turns on a steel shaft and fabricated steel drive bearing. The drum surface is divided into longitudinal sections each of which is drained through molded rubber grids. These grids can be snapped in and out of place for inspection and replacement. The filter tank is also of molded plastic construction and is provided with polyvinyl chloride feed connections. For further technical data from Dorr-Oliver, circle Number 400 on Data Post Card.



ADSCO Corruflex Expansion Joint with #316 stainless steel element. From the position of the tie-rods, note the pipe movement the joint is absorbing.



In this section of the Houdriflow unit, there are 12 ADSCO Corruflex Expansion Joints with #316 stainless steel elements. Temperature here is 1100°F.



Houdriflow Catalytic Cracking Unit, Marcus Hook Refinery, Sun Oil Co.

LET THE PIPES SQUIRM . . .

ADSCO EXPANSION JOINTS *are on the job*

Here, at the Marcus Hook Refinery of Sun Oil Co., temperatures run high. The piping naturally moves around a bit. But Sun engineers don't worry because they installed 62 ADSCO Corruflex Expansion Joints to take the movement. Lateral offset, angular rotation, off-tackle slants . . . name it and ADSCO Expansion Joints can absorb it. If you expect your pipes will get frisky, call the nearest ADSCO sales-engineer. He'll know what to do.

ADSCO DIVISION
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Member, Expansion Joint Manufacturers Association

YUBA CONSOLIDATED INDUSTRIES, INC.

CEP's DATA SERVICE

Services *from page 88*

389 Packaged Plant Construction. Wigton-Abbott Corp. offers complete service from planning to production. Booklet.

390 Simplified Computer Programming Method. Four-page bulletin from Bendix Computer Division gives details of new system for use with Bendix G-15 general purpose digital computer.

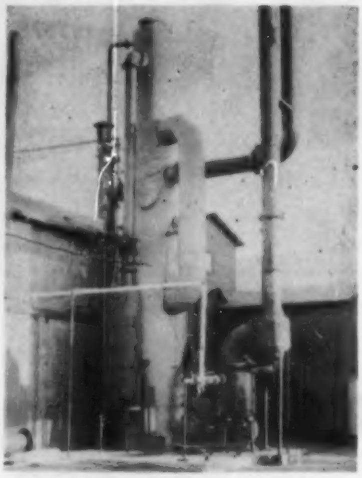
391 Radiation Protection Services. Controls for Radiation, Inc. offers brochure on its radiation hazards control program.

392 Equipment Design Service. Haveg Industries, Inc. offers new design service for heat exchangers, falling film absorbers, towers, chlorine coolers. Bulletin.

393 Logarithmic Mean Temperature Difference Chart. Simplifies design work on heat exchange equipment. Dean Products, Inc.

394 Equipment Fabrication. Bulletin from Richmond Engineering Co. details their facilities for construction of chemical processing equipment.

DEVELOPMENTS OF THE MONTH



SPECIAL CONDENSING TOWER
Circle No. 401 on Data Post Card.

The Convactor, made by Croll-Reynolds, is a combination of two condensers and a vacuum cooling chamber. Contaminated vapors from a process enter the unit through the vapor inlet on the jet condenser. Water vapor and vapors less volatile than water are condensed, and the condensate and the condensing water pass into the flash chamber, or vacuum cooling compartment, where the heat of condensation is immediately removed. The pressure in the cooling chamber is maintained at a point equivalent to that of the required temperature of the chilled condensate. The cooled condensate is then recirculated through the same jet condenser. Periodic blowdown or bleed-off from the flash chamber permits recovery of any valuable products.

For more technical details on this recent development, circle Number 401 on the Data Post Card.

CEP's DATA SERVICE

Materials *from page 90*

384 Stainless Steel Data Chart. Durable cardboard chart gives relative corrosion-resistance of 34 standard grades of stainless steel. Peter A. Frasse & Co.

385 Corrosion - Resistant Coatings. Folder from Wisconsin Protective Coating Co. lists bulletins available on wide variety of coating materials.

386 Booklet on Vinyl Acetate Monomer. Operating procedures, physical properties, specifications, shipping data, applications, polymerization techniques, analytical procedures, and physiological properties. Union Carbide Chemicals Co.

387 Lining and Coating Systems. Bulletin from Glidden Co. describes properties and application of Nu-Pon Cote lining and coating systems.

DEVELOPMENTS OF THE MONTH

DATA ON HIGH VACUUM TECHNIQUES

Circle No. 402 on Data Post Card.

Consolidated Electrodynamics, Rochester division, offers two condensed bulletins on high-vacuum technology. The first covers many types of high-vacuum vapor pumps, gives performance curves, speed-pressure curves, throughput-pressure curves, other engineering data in graphic and tabular form. Featured is a two-page table giving condensed data on vapor pumps. Shown are pump type, operating range, maximum speed, limiting forepressure, recommended fluid, recommended forepump, heater power, heater voltage, and cooling water requirements.

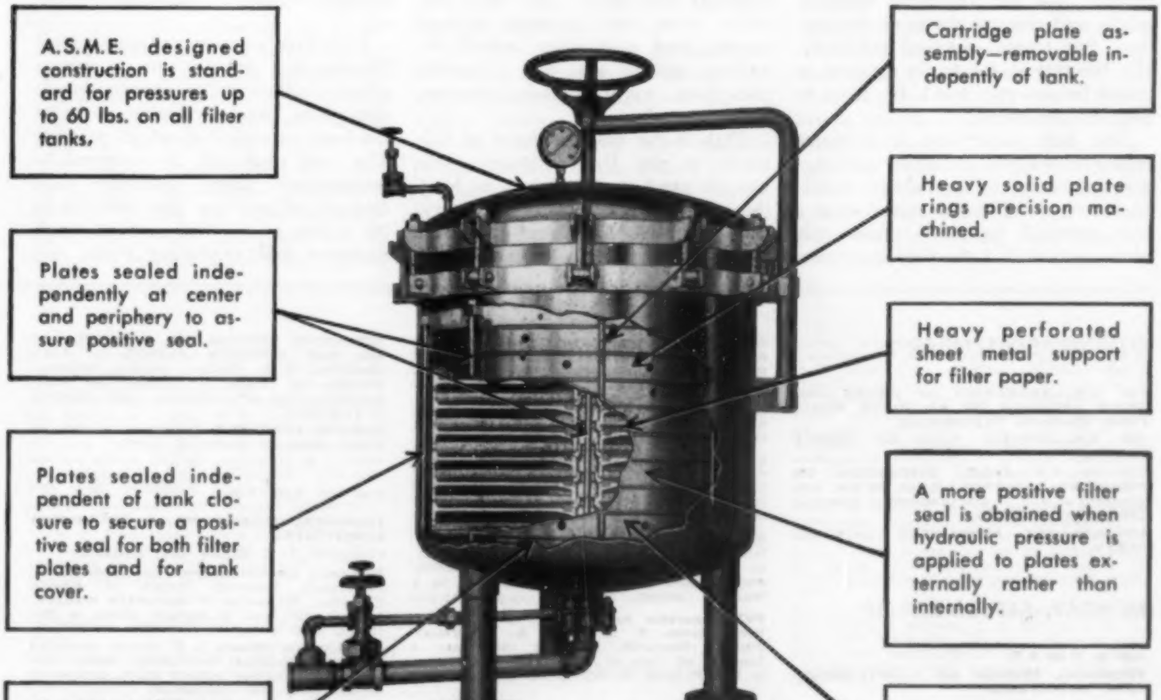
Bulletin 4-80 gives details of vacuum-jacketed transfer lines for transfer of low temperature liquid oxidizers. Described are transfer lines, gauges, baffles, traps, pumps, and leak detectors. Of special interest to chemical engineers involved in missile and rocket work. For copies of these unusual bulletins, circle Number 402 on Data Post Card.

SPARKLER
horizontal plate
FILTERS

Undisputed First Choice

with engineers who have had occasion to thoroughly test this type of filter. Shown here are structural features that are the result of over 30 years experience in building this one filter.

Aloysius C. Kracklauer
Originator of the Horizontal Plate Filter



The Sparkler, original exclusive horizontal plate design and flow principle, has never been equalled for efficiency and dependability in filtering with any and all types of filter aids. The cake maintains its original position as formed regardless of pressure fluctuation flow rate or viscosity. No break-through is possible, even with a complete shut down of the filter. Filtering can be resumed with perfect safety at any time. With Sparkler plate construction a completely sanitary filter can be furnished.

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Sparkler International Ltd.—Manufacturing plants in Canada, Holland, Italy and Australia.
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Salt Lake City
. . . an industrial hub
of the mountain states

SAFETY CONFERENCE—Air & ammonia plant operators and designers again sponsor program. Four sessions will serve as sequel to original meeting in Baltimore (Sept. '57) with a new agenda. Of primary interest to those responsible for operation, maintenance, and technical service of these plants. Symposia feature short introductory talks on each topic followed by discussion from floor.

In Salt Lake City everything from the towering Wasatch Mountains to the wide industrial activity is spectacular. Spectacular too is the A.I.Ch.E. National Meeting (September 21-24) technical program and plant trips.

In the Salt Lake City in September the climate is perfect, the scenery is perfect, the plant trips are just about perfect, and the Technical Program might well deserve the same description. Big, varied, practical and basically theoretical, the entire program is listed below—you won't be able to hear all you should.

The Salt Lake area is a major center of Western industrial activity—a major center in the nation's industrial activity. Basic reason—this is a raw material paradise. From salt alone—and Salt Lake City has quite a bit of salt, in fact the supply is unlimited—electrolytic processing yields 21 different chemicals, and 34 major chemical derivatives are extracted. Other basic raw materials include copper, lead, zinc, silver, cobalt, petroleum, natural gas, coal, Gilsonite, phosphate, sulfur, potash, uranium, and many others.

Utah is the only producer of Gilsonite in the United States. This unique product, occurring in long, thin, deep veins over miles of countryside, has been the subject of a great deal of interest from the process industries in recent years, finds great potential use for high quality metallurgical coke, high octane gasoline, asphalt tile, paint, roofing, insulation, etc.

U. S. Steel's Columbia-Geneva Steel Division has recently put on stream a multi-million dollar nitrogen products plant. Steel production capacity has been expanded about 20 percent. The new pipe mill is equipped to manufacture large diameter high strength oil and gas pipe from 20 to 36 inches in diameter, and a small diameter mill producing water and

SUNDAY, SEPTEMBER 21

8:30 A.M.—BROADCAST OF ORGAN AND CHOIR PROGRAM OF RELIGIOUS MUSIC FROM MORMON TABERNACLE.

9:00 A.M.—SPECIAL TOUR OF TEMPLE SQUARE.

~~2:00~~ 1:30 P.M.—PANEL DISCUSSION ON FINANCING RESEARCH, Joseph Barker, past president of E. J. C. and president of Research Corporation, moderator.

8:00-10:00—GET ACQUAINTED COCKTAIL PARTY.

MONDAY, SEPTEMBER 22

9:00 to 11:30 A.M.

TECHNICAL SESSION NO. 1—INTERMOUNTAIN INDUSTRIES.

Chairman, W. C. Bauer, Intermountain Chemical Co.

Development of Intermountain chemical process industries, E. Nelson, First Security Bank. Expected growth of region's industries with emphasis on new areas of activity.

Mineral reserves of the Intermountain region, V. E. Larsen, Food Machinery & Chemical. Analysis of tremendous reserves of organic and inorganic raw materials with suggested alternates to some conventional materials.

Soda ash from Trona, W. R. Frint, Intermountain Chemical. Unique process with emphasis on technological discussion.

MSC char process, L. Berg & D. E. Atkinson, Montana State College. Process for converting western coals to char and aromatic oils, with economic data suggesting commercial possibilities.

Fluosolids calcining of Western phosphate rock, D. L. King, San Francisco Chemical Co. Data from an 18-month pilot-plant run, with plans for operating two 3-hearth reactors under construction.

TECHNICAL SESSION NO. 2—HIGH TEMPERATURE KINETICS AND TRANSPORT PHENOMENA—I, Chairman, W. R. Marshall, Jr., Univ. of Wisconsin.

High temperature chemical kinetics, K. E. Shuler, Bureau of Standards. A random survey of problems.

Chemical kinetics of non-equilibrium populations, H. Eyring & Taikyou Ree, Univ. of Utah. Stepwise shifts of various materials from a ground state to very highly excited states.

Chemical kinetics in detonations, J. O. Hirschfelder, C. F. Curtiss, & M. P. Barnett, Univ. of Wisconsin. Heat conductivity, diffusion, and viscosity are taken into account in a realistic fashion.

PVT apparatus for reaction rates at high temperatures, R. B. Smith & T. Dresser, Sinclair Research. Reaction rates are a function of rate of volume increase. Temp. to 1000 F, press. to 1500 lb./sq. in.

TECHNICAL SESSION NO. 3—CRYSTALLIZATION.

Chairmen: H. M. Schoen, American Cyanamid, and C. S. Grove, Jr., Syracuse Univ.

Crystallization studies in the Trona process, D. E. Garrett, Amer. Potash & Chemical. Design sequence and the most critical control and design factors.

Recovery of solids from solutions by crystallization, H. Svanoe, Struthers Wells. Metastable supersaturation for unseeded solutions, supersaturation in continuous processes containing small crystals, and factors affecting crystal uniformity, purity, and habit.

Rational control factors affecting performance of continuous crystallizers, W. C. Saeman, Olin Mathieson. Controlling nucleation crystal size, and quality in continuous operations. Research is emphasized as a tool.

Circulating magma crystallizers, H. H. Newman & R. C. Bennett, Swenson. Development and performance of a unit of improved design and operation.

TECHNICAL SESSION NO. 4—SAFETY IN AIR AND AMMONIA PLANTS—I. (AIR). Chairman: N. H. Walton, Atlantic Refining. Agenda: Air plant air intake, air compressors, silica gel adsorbers, and reboilers or vaporizers.

12-NOON, LUNCHEON. Welcoming address by Utah's Governor George D. Clyde.

2:00 TO 5:00 P.M.

TECHNICAL SESSION NO. 5—PETROLEUM SUBSTITUTES.

Chairman: J. H. Hirsch, Gulf Research.

Petroleum substitutes from tar sands, D. S. Pasternack, Research Council of Alberta (Canada). Production of marketable products, both in situ and in surface plants is discussed, with attractive economics for latter.

The Gilsonite refinery, L. B. Morris, American Gilsonite. Technical development, design, and operation of unique refinery which emphasizes metallurgical coke production.

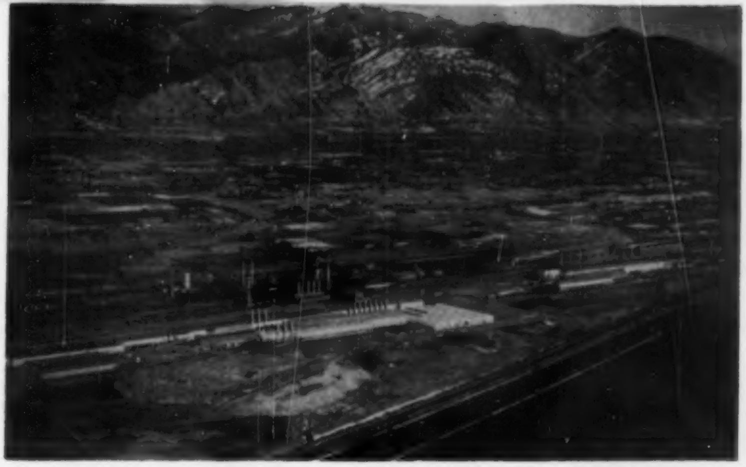
Synthetic liquid fuels by Fischer-Tropsch: current status, J. H. Field, H. E. Benson & R. B. Anderson, Bureau of Mines. A review of activities and developments, with commercial data from the Sasol and Amoco plants.

SASOL: Gasoline from coal via Synthol process, L. W. Garrett, Jr., M. W. Kellogg. Review of the variables affecting the design and operation of the Sasol synthesis plant, plus a discussion of the other processing steps.

Progress in oil shale research, F. L. Hartley, Union Oil. Current progress in mining and retorting oil shale, with data on products available and economics.

TECHNICAL SESSION NO. 6—HIGH TEMPERATURE KINETICS AND TRANSPORT PHENOMENA—II, Chairman: W. R. Marshall, Jr., Univ. of Wisconsin.

Kinetics of reactions of active metals with O_2 & N_2, M. S. Chandrasekharaiah, & J. L. Margrave, Univ. of Wisconsin. Rates have been measured for reactions of several alkali, alkaline earth, and transition metals with gases at various temperatures and pressures.



Magnificent setting for Salt Lake industry is typified by this U. S. Steel Columbia-Geneva Division works.

oil pipe from 4 to 12¾ inches in diameter. Service facilities for coating and wrapping the small diameter pipe are a feature of this new plant.

The Kennecott Copper mine at Bingham, Utah, scene of one of the most interesting field trips, yields approximately 30% of the nation's copper. Kennecott has its new research center located near the University of Utah in Salt Lake City.

Recently tremendous oil and natural gas reserves have been developed in Utah in a number of widely separated areas. Pipelines are in operation to Salt Lake City and to Texas and California. There are four oil refineries adjacent to Salt Lake City where gasoline is refined along with the production of lubricating oils, wax, heating oils, fuel oils, and asphaltic materials.

The carnotite ores of the area and the autunite deposits are the greatest proven sources of uranium in the United States. These raw materials are the basis for the large uranium process industry in the state.

Many new industries have located in the Salt Lake Valley. These include: Marquart Aircraft Company facilities to manufacture and test ram-jet engines; Thiokol Chemical Company's rocket and guided missle test center; Sperry Rand, electronics; Litton Industries Inc., electronics; Pacific Northwest Pipeline Corporation, natural gas.

Plant trips—Special events

With such a wealth of industry, unique and highly spectacular industry set in some of the most scenic country in the nation, plant trips deserve special mention this time.

There will be a trip to the new nitrogen products plant of U. S. Steel's Geneva Works surrounded by the soaring Wasatch Mountains, and Kennecott's copper mine which is the largest open pit copper mine in the entire world. Another must is Vitro Uranium's acid leach and solvent extraction plant, and Western Phosphate's phosphoric fertilizer plant, and Asarco's Garfield smelter with associated sulfuric acid plants.

Among the highlight non-technical events will be a trip to famous resort Big Cottonwood Canyon with a barbecue at Alpine Rose Lodge, an historical tour of this historical city, trip through the world famous Tabernacle, and the Tuesday night banquet and dance.

Kinetics of sintering processes, W. D. Kingery, MIT. Kinetics of the diffusion-controlled sintering processes have been developed, leading to better control of process variables.

Turbulent heat transfer to dissociating N_2O_4 gas flowing in a tube, W. F. Krieve, D. Altman, & D. M. Mason, Stanford Univ. Rates for both heating and cooling conditions in the gas system flowing turbulently in a small tube. Reynolds nos. 7500-25,000. Remarkably high coefficients obtained.

Olivine chlorination by fluidized solids techniques, K. B. Bengston & L. N. Johanson, Univ. of Washington. Data from 57 experimental runs are reported and analysed. Temperatures ranged from 900-1320 C. Ore is largely magnesium silicate.

TECHNICAL SESSION NO. 7—CENTRIFUGATION.

Chairman: J. O. Maloney, Univ. of Kansas.

Characteristics of fixed-impeller hydroclones, H. H. Sineath, Amer. Viscose, & J. M. DallaValle, Georgia Tech. Conventional and fixed impeller hydroclones are compared, indicating the latter separate at larger particle diameters (70-200 mesh) with lower energy loss.

Energy requirements and efficiencies of miniature hydroclones, D. E. Matschke, Northwestern Univ., & D. A. Dahlstrom, Eimco. Energy requirements and solid elimination efficiency of cyclones of 10-40 mm. dia. were determined using 2.74 gravity clay, 93% finer than 25 microns.

Centrifugal filtration through beds of small spheres, J. B. Bingeman, Ethyl Corp., & Jesse Coates, Louisiana State Univ. Data taken with beds of plastic spheres in four mesh sizes are correlated using a modified D'Arcy equation.

Comparison of resistances of cakes formed in filters and centrifuges, V. V. Valleroy, Esso Produc. Res., & J. O. Maloney, Univ. of Kansas. Resistances to fluid flow through porous beds of plastic spheres were measured in pressure, vacuum, and centrifugal filters, and correlated by a common basic equation.

Development of a pressurized centrifuge for a polyolefin process catalyst separation, J. A. Weedman & W. E. Payne, Phillips Petrol., & O. W. Johnson, Dorr-Oliver. A disc-type, nozzle-bowl centrifuge for operation to 110 lb./sq. in. was developed for removing finely-divided, spent catalyst particles from reactor effluent.

TECHNICAL SESSION NO. 8—AIR & AMMONIA PLANT SAFETY—II (AIR).

Chairman: N. H. Walton, Atlantic Refining. Agenda: Air plant instrumentation, construction materials & practice, shutdowns, and description and analysis of air plant fires and explosions.

EVENING—CANYON BARBECUE.

TUESDAY, SEPTEMBER 23

9:00 to 11:30 A.M.
TECHNICAL SESSION NO. 9—IMPROVED UTILIZATION OF TECHNICAL MANPOWER.

Chairman: J. F. Cheely, Ethyl Corp.

Training program for chemical engineers, P. N. Kuehler, Humble. Description of a program which continues throughout the professional career.

Computer—giant slide rule for improving engineering effectiveness, H. F. Kraemer, Ethyl Corp. Training of personnel in using a small digital computer.

Use of engineering aides to increase effectiveness of chemical engineers, R. Meyer, Esso Std. Oil. Aides for freeing engineers and scientists for more creative work.

Use of outside agencies, N. K. Hiester, Stanford Research Institute. Services available from outside groups for temporary overloads of technical problems.

TECHNICAL SESSION NO. 10—THERMODYNAMIC BEHAVIOUR OF POLAR SYSTEMS.
Chairman: J. M. Smith, Northwestern Univ.

Survey of equilibrium and non-equilibrium properties of polar substances, J. R. Brock & R. B. Bird, Univ. of Wisc. Thermodynamic properties for polar substances are calculated by means of the 2nd and 3d coefficient.

Phase equilibria and mixtures of polar and non-polar compounds, Cline Black, Shell Development. Correlations which make use of temperature variations of activity coefficients are illustrated with binary mixtures of benzene and the n-aliphatic alcohols.

Heats of solution by the method of group interaction, extension to polar systems, M. N. Papadopoulos and E. L. Derr, Shell Development. Group interaction for predicting heats of mixing of nonelectrolytes is applied to binary solutions of polar and nonpolar molecules.

Phase behavior and solubility relations of the benzene-water systems, C. J. Rebert & W. B. Kay, Ohio State Univ. Pressure at liquid and vapor phase boundaries of 15 mixtures of benzene and water were determined within the range from 200 to 357 C.

TECHNICAL SESSION NO. 11—ETHYLENE PRODUCTION—I.

Chairman: H. C. Schutt, Consulting Engr., Boston.

Effect of pressure and equilibrium approach in light hydrocarbon pyrolysis, H. C. Schutt. Performance data from commercial pyrolysis coils are used to develop the importance of the equilibrium approach in design of homogeneous gas phase pyrolysis reactors. Reaction order and mechanism are indicated.

Process variables in production of ethylene from fluid fossil fuels, H. R. Linden & J. M. Reid, Inst. of Gas Technology. Thermodynamic and kinetic factors determining compositions of gaseous pyrolysis products were determined. Correlations were developed for making direct exploratory estimates of ethylene and propylene yields from feedstocks ranging from propane to residual petroleum oils.

A computer study of the free-radical mechanism of ethane pyrolysis, R. H. Snow, R. E. Peck, & C. G. von Fredersdorff, Ill. Inst. of

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Tech. The pseudoequilibrium behavior in ethane pyrolysis has been reproduced by calculations based on a reaction mechanism, giving results which can be incorporated into reactor performance calculations to replace empirical correlations, and thus widen the range of reliable conditions.

Acetylene removal from polyethylene grade ethylene, R. E. Reitmeier & H. W. Fleming, Catalysts & Chemicals, Inc. Abstract not available.

TECHNICAL SESSION NO. 12—SAFETY IN AIR & AMMONIA PLANTS—III (AMMONIA).

Chairman: N. H. Walton, Atlantic Refining.

Agenda: Ammonia plant H_2 purification, nat. gas reformer furnaces, compressors, high pressure equipment, and tankage & spheres.

12-NOON. LUNCHEON. Speaker to be announced.

2:00-5:00 P. M.

TECHNICAL SESSION NO. 13—ALTERNATE ENERGY SOURCES.

Chairman: H. P. Nolting, Standard Oil (Ind.).

Developments in solar energy collectors, J. A. Duffie, O. G. Löf, I. M. A. Salam, Univ. of Wisconsin. Methods for improving collector performance or reducing costs are reported, including use of semi-transparent coatings.

Fuel cells, E. Gorin & H. L. Recht, Pittsburgh Consolidation Coal. Experimental work towards development of a high temperature fuel cell is reported, some performance data are given. Factors which limit ultimate performance are discussed. Cell life problems are outlined.

Boron hydrides, L. A. Barry, Callery Chemical. Problems associated with a program of development of the hydrides, and techniques employed in their solution. Bench- and pilot scale operations will be illustrated.

Free radicals, G. C. Szego, G-E. A discussion of the formation and recombination of free radicals, including the relationship of energy emission to potential properties as propellants.

Fusion as a future energy source, D. H. Imhoff, G-E. Review of basic physical processes, description of current experimental programs, and discussion of possible impact on chemical processing of present level of research on plasma, the fourth form of matter.

TECHNICAL SESSION NO. 14—GENERAL—I. (THERMODYNAMICS).

Chairman: To be announced.

Treatment of thermodynamic data for homogeneous binary systems, H. C. Van Ness and R. V. Mrazek, Rensselaer. Methods are described for the treatment of thermodynamic data on binary systems, which are both precise and convenient.

Fugacities in high-pressure equilibria and in rate processes, J. M. Prausnitz, U. of Calif., Berkeley, Calif. New techniques are for calculating vaporphase fugacity coefficients in nonideal mixtures.

Improved equation of state of gases; physical and thermodynamic properties of trifluoromethane, J. J. Martin, R. M. Kapoor, N. De Nevers, & Y. C. Hou, Univ. of Mich. Abstract not available.

Density: Reduced State Correlations for the Inert Gases, C. E. Hamrin, Jr. & George Thodos, Northwestern Univ. Principle of corresponding states has been adapted to the correlation of densities for non-polar substances with the critical compressibility factor, z_c as an independent parameter.

Studies of the Cation Exchange System Fe^{+++}—H^+ at high concentrations, R. C. Vasishth, Reichhold Chemical, & M. M. David, Univ. of Wash. Equilibrium and kinetic data are presented for the subject system on a sulfonated polystyrene exchanger.

TECHNICAL SESSION NO. 15—ETHYLENE.

Chairman: H. C. Shutt, Consulting Engr., Boston.

Demethanization in ethylene recovery systems, J. R. Fair, W. L. Bolles, & W. R. Nisbit, Monsanto. Commercial aspects of demethanization, the most expensive step in ethylene recovery from pyrolysis gas, are discussed. Problems of design and operation are related to included data, to permit preliminary evaluations of alternates.

Process design of ethylene-ethane fractionator, J. W. Davison & G. E. Hays, Phillips Petroleum. Process design calculations of reflux, number of theoretical trays, tower diameter, heat exchange surface, and compression re-

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Salt Lake City

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quirements for ethylene-ethane fractionators are shown to be aided by a correlation plot of relative ethylene-ethane volatility versus reciprocal temperature for constant liquid phase composition.

Ethylene storage and distribution on a large scale. V. N. Hurd, W. H. LeGrand, W. H. Litchfield, M. Martin, & D. C. Scheling, Gulf Oil. Abstract not available.

TECHNICAL SESSION NO. 16—SAFETY IN AIR & AMMONIA PLANTS—IV (AMMONIA). Chairman: N. H. Walton, Atlantic Refining.

Agenda: Ammonia tank cars & trucks, preparation for repairs including "hot" work, description & analysis of hydrogen cold box explosion, materials of construction and metal inspection, and personnel safety.

Evening—Banquet. Address by J. Reuben Clark of First Presidency, Latter Day Saints Church.

WEDNESDAY, SEPTEMBER 24

9:00-11:30 A. M.

TECHNICAL SESSION NO. 17—AIR POLLUTION. Chairman: W. L. Faith, Air Pollution Foundation.

Air pollution control facilities at a steel mill. W. T. Purvance, U. S. Steel. A unique engineering solution to fluoride air pollution problem. Solids which react with and remove pollutants are injected into gas stream.

Gas absorption in spray contactors, K. E. Lunde, Stanford Research Inst. Data on counter cross- and parallel-flow spray contactors are recorrelated into improved expressions generally similar to those for single-drop data.

Motor fuel composition as related to air pollution effects of irradiated auto exhaust. E. R. Stephens, Franklin Institute, & E. A. Schuck, Stanford Research Inst. Effect of olefinic, aromatic, and paraffinic content of fuel on eye irritation, and other physical-chemical characteristics of irradiated automobile exhausts.

Combustibility of simulated automobile-exhaust gases, Bernard Greifer and Raymond Friedman, Atlantic Research. Flammability of synthetic automobile exhaust gas mixtures is predictable from a knowledge of composition and initial temperature.

TECHNICAL SESSION NO. 18—GENERAL II. (FLUID MECHANICS). Chairman: To be announced.

Transition from laminar to turbulent flow in pipes, N. W. Ryan, Univ. of Utah, and M. M. Johnson, Phillips Petroleum. Development of an experimentally-confirmed method for predicting the transition from laminar to turbulent flow. Non-Newtonian fluid applications are emphasized.

Turbulent liquid flow down vertical walls. H. M. Belkin, A. A. McLeod, C. C. Monrad, & R. R. Rothfus, Carnegie Tech. Photographic methods permit study of the behavior of water flowing freely down vertical surfaces under the influence of gravity at Reynolds numbers between 200 and 30.000.

Annular flow model for calculating two-phase pressure drops in natural-circulation boiling systems, S. G. Bankoff, Rose Polytechnic. Abstract not available.

Heat transfer and fluid flow characteristics of aqueous thorium oxide slurries, D. G. Thomas, ORNL. Heat transfer and pressure drop data are reported for Newtonian and non-Newtonian slurries at Reynolds numbers from 1000 to 150.000.

Factors affecting air lift performance, H. W. Chamberlain & D. M. Paige, Phillips Petroleum. Effects of submergence ratio, liquid properties, and equipment design variables on air lift capacity.

TECHNICAL SESSION NO. 19—CHEMICAL ENGINEERING IN NUCLEAR APPLICATIONS. Chairman: N. A. Spector, Vitro.

Pilot plant studies of the low temperature distillation of hydrogen isotopes, T. M. Flynn, K. D. Timmerhaus, & D. H. Weitzel, Bur. of Standards. Operating data from the Boulder, Colo. pilot plant separating the HD isotope from liquid hydrogen, described in the June '58 issue of CEP.

Stage efficiency in the liquid-liquid extraction of uranium, L. D. Lash and J. D. Moore, Vitro Uranium Co. The influence of foreign ions, solute concentration, and operating conditions on stage efficiency in the liquid-liquid extraction of uranium from acid leach liquors.

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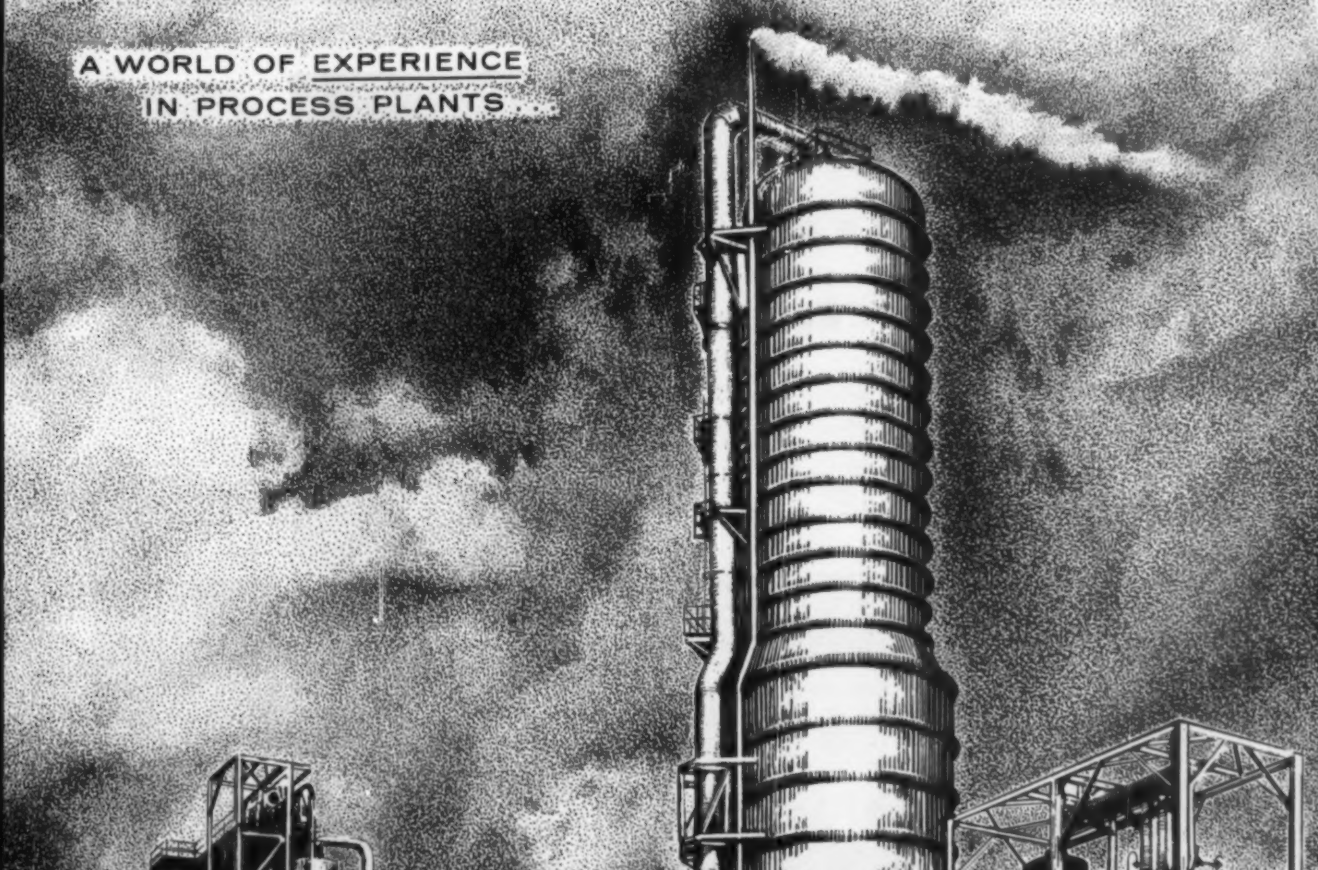

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Salt Lake City

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A single stage, high efficiency, fluidized bed reactor, R. P. Levey, Jr., A. de la Garza, H. M. Heidt, S. C. Jacobs, P. E. Trent, Union Carbide Nuclear. Development and performance of a single stage, high efficiency, non-mixing fluidized bed reactor for the production of UF_4 and UO_2.

Drying and calcining of raffinate from uranyl nitrate extraction, D. S. Arnold, Natl Lead of Ohio. Pilot plant and plant start-up data on drum drying and rotary calcining of raffinate from uranyl nitrate extraction.

Titanium for chemical processing equipment, R. W. Wirta, G-E. Corrosion resistance and techniques of fabrication for titanium process equipment.

TECHNICAL SESSION NO. 20—GENERAL III. (PETROLEUM REFINING). Chairman: To be announced.

Multicomponent distillation on a large digital computer, Pt. II—Generalization with side stream stripping, N. R. Amundsen, Univ. of Minnesota, A. J. Pontinen & J. W. Tierney, Remington Rand Univac. A previously published method generalized to include side-stream stripping.

High speed computing by use of the Thiele and Geddes approach to multicomponent distillations, W. N. Lyster, Humble, & D. S. Billingsley, S. L. Sullivan, & C. D. Holland, Texas Engrg. Exper. Station. A rapidly converging method tested on more than 40 examples including a wide variety of feeds and plates. Adapted to IBM 650 & 705 machines.

Use of cobalt-moly catalyst for catalytic reformer feed purification, E. M. Blue & B. Spurlock, California Research Corp. The ability of cobalt-moly catalyst to remove poisons from the catalytic reformer feed and the effect of the poisons on the catalyst.

2:00-5:00 P. M.
TECHNICAL SESSION NO. 21—DRY CLASSIFICATION. Chairman: To be announced.
Papers to be announced.

TECHNICAL SESSION NO. 22—GENERAL IV. Chairman: To be anounced.

Velocity computations for hydraulic tests of ETR fuel elements, A. W. Brown, J. M. Waage, J. R. McGeachin, Phillips Petroleum. A method is developed and tested for predicting flow across parallel plates of reactor fuel assemblies.

Vaporization of superheated drops in liquids, G. R. Moore, and W. R. Marshall, Jr. U of Wisconsin. A modified theory is shown to correctly describe the process of formation of bubbles in superheated liquids in the absence of external influences.

A correlation of variables affecting the absorption of oxygen from gas bubbles in water, W. W. Eckenfelder, Jr. Manhattan College. Correlations developed from laboratory data are extended to commercial diffusion devices.

Cross-flow zone refining, W. G. Pfann and R. W. Hamming, Bell Telephone Labs. A distillation analogy is applied to show the advantage of continuous crossflow zone refining as compared to batch methods.

Design of a solar absorption space cooler, R. Chung, G. O. G. Löf and J. A. Duffie, Univ. of Wisconsin. Some of the design problems of the combination of a flatplate solar collector with an absorption air-conditioner have been studied, and a design established for a cooler of 8,000 BTU/hr. capacity.

TECHNICAL SESSION NO. 23—FOAMS AND FROTHS. Chairman: J. Louis York, Univ. of Michigan.

Foam separation—effects of operating variables in a foam separation column, V. Kevorkian and E. L. Gaden, Jr. Columbia Univ. Effects of operating variables are reported on the actual and equilibrium separation of surface-active agents from their aqueous solutions in a foam separation column.

Foam fractionation of metals, R. W. Schnepf and E. L. Gaden, Jr. Columbia Univ. Effects of operating variables and solution characteristics on the selective separation of metals in aqueous solution.

Practical industrial foam control, E. G. Tajkowski, G-E. Various industrial aspects of foam uses and control in both aqueous and non-aqueous systems are discussed. Comparative defoaming costs are included.

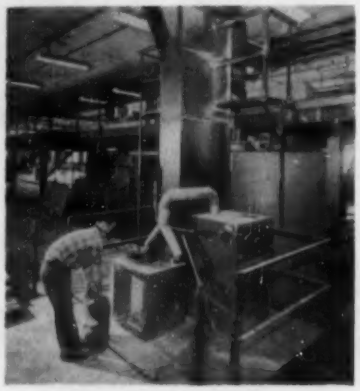
Foaming problems with Gilsonite-coker gas oil mixtures, W. J. Rossi, Calif. Research Corp. Practical operating problems and their solutions for foaming in the Gilsonite melter are discussed.

Motor bucket elevator simplifies handling

Mobile application of a bucket elevator has facilitated handling of 9 tons per hour of dichlorophenoxyacetic acid and has simplified reactor charging at American Chemical Paint Co., St. Joseph, Mo.

Powdered acid, weighing 50 lb./cu. ft., is handled in 8 by 5-in. malleable iron buckets affixed to C-102 chain at 16-in. intervals. Buckets are discharged by centrifugal action directly into the reactors as they pass over the head sprockets. Takeups consist of adjustable head shafts that provide a means of compensation for chain length variations that may occur through wear, temperature changes, or atmospheric conditions.

At American Chemical Paint, a charging platform was originally used to feed chemicals into the reactors below. In the former method of charging bulk chemicals, a pallet load of bagged dichlorophenoxyacetic acid was raised by fork-lift truck up to the platform where a man tore open the bags and poured the contents into the charging opening. Now, with the installation of the bucket elevator, the line of travel parallels these openings and the bulk stocks. One man can feed the necessary amount of chemicals directly into the bucket elevator from floor level.



The self-propelled carriage is controlled by push-buttons located at the top of the elevator. A service platform allows the operator access to the controls so that the elevator discharge spouts can be positioned over the proper opening.

Installation of the new system at American was by Link-Belt Co.

21 Nations to exhibit at Second UN Geneva Atomic Conference

Fusion devices, operating fission reactors, and isotope uses are among the exhibits to be shown by 21 nations at the upcoming Second UN International Conference on the Peaceful Uses of Atomic Energy, to be held at Geneva, Switzerland, September 1-13, 1958.

Housed in a special building now under construction at Geneva, this Second Conference will have exhibits covering four times as much floor space, and coming from 21 countries instead of nine.

The exhibit on controlled thermonuclear fusion (some 50% of the U.S. exhibit will be devoted to this highly experimental field) will include "actual operating devices" from the U.S., an historical description of research in the United Kingdom and a model of the ZETA device from Harwell, a display by France, and models, diagrams and equipment by the USSR illustrating scientific papers submitted by the Soviet.

The U.S. fusion exhibit will be "essentially a status report on the principal research paths" being followed at Los Alamos, the U. of Cal.'s Radiation Laboratory, Princeton's Forrestal Research Center, and ORNL.

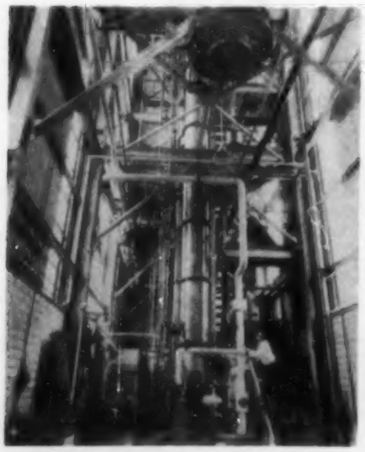
The exhibits of progress in fusion will serve as a supplement to more than 100 papers to be delivered at the conference on the subject. Papers will be both theoretical, concerned with the fundamental problems involved, and will also describe such devices as the UK's ZETA, Princeton's "Stellerator," the DCX at ORNL, the "mirror machine" at Livermore (U. of Cal.), and a "toroidal" chamber in the USSR.

Turning to fission reactors, which are already producing power in a number of countries, among the reactors and models will be a 10-kw Argonaut research reactor from the U.S. as well as a model of the Shippingport pressure vessel and core. Other major fission exhibits will come from the U.K., France, Italy, Norway, and Sweden.

A 50% expansion in plasticizer production capacity has been effected at Pittsburgh Coke & Chemical, Industrial Chemicals Division.

New plastic materials, plant expansions, mark active month for process industries

A new urethane material that will challenge the metal parts industry has been developed by Mobay Chemical. The material can be cast as well as molded, has the resiliency of rubber with the strength of metal. Still in the testing and planning stage, the new material could have a market of 18-60 million pounds in the automotive industry alone, offers promise for use in industrial equipment, construction and materials handling . . . **On the phenolic front,** a heat-reactive phenolic resin for use in neoprene adhesives has been developed by Schenectady Resins Div. of Schenectady Varnish Co. Claim: it makes possible solvent-type neoprene adhesives with the highest heat resistance available on the market today . . . **Another low-temperature process plant** will be built by Linde Co. Division of Union Carbide. The plant, a 300-ton a day liquid oxygen and nitrogen facility, will be built at Pittsburg, Calif., will serve the needs of the missile industries for the liquefied gases . . . **Construction of a $1 million molybdenum metal and molybdenum-base alloy plant** is just about completed for American Metal Climax, Inc., at Coldwater, Mich. Scheduled for production by late 1958, the strategically important plant will be operated by the company's subsidiary, Climax Molybdenum Co. of Michigan. Capacity will be 800,000 pounds of castings annually . . . **One of the largest biological industrial waste treatment plants in the world** has been built by American Cyanamid at a cost of $4.5 million. Located at Bound Brook, N. J., the plant will give secondary treatment to the local community wastes as well as treat the company's own effluent . . . **Special aluminum bronze alloys and alloy products, used extensively in the chemical process industries,** will be made in Garland, Texas, at the new plant of Ampco Metal, Inc . . . **An integrated general service solvent recovery plant** has been engineered for CIBA Pharmaceutical Products, Inc. at Summit, N. J., by Badger Mfg. Co. of Cambridge, Mass. Construction was by CIBA itself. A three unit plant, each of the new units will recover and rework a different class of solvents. A feature of the plant is the distillation



Distillation Columns—Ciba Plant

columns designed for quick drainage, easy cleaning, and rapid switching of solvent streams . . . **A new biologicals center is producing a polyvalent influenza vaccine** for Chas. Pfizer & Co. at Terre Haute, Ind. The new center is also equipped to produce a variety of other vaccines . . . **The application of the high intensity electric arc to possible "ion propulsion,"** is the subject of a contract just awarded to Vitro Laboratories (Vitro Corp.) by U. S. Air Force Office of Scientific Research . . . **Construction of Canada's first atomic power station will be resumed this month.** Known as NPD (Nuclear Power Demonstration), the plant will produce 20,000 Kw of electricity when it goes into operation in 1961 . . . **First Houdry catalytic reforming unit in the Far East** has gone on-stream at the Yokkaichi refinery of the Daikyo Oil Co., Ltd. of Tokyo. A 3,000 barrel-a-day unit, it was engineered by both Houdry Process Corp. and Refinery Engineering Co. of Tulsa, and constructed by Daikyo . . . **A new pilot-plant coating laboratory has been placed in operation** by Arthur D. Little at Cambridge, Mass. . . . **Russian instrumentation education will be discussed** by a leading Soviet educator at the 13th Annual Instrument-Automation conference, Sept. 15-19, Philadelphia . . . **National Lead Co. will manufacture nuclear reactor fuel elements** for power, research and propulsion applications in Albany, N. Y. . . . **Thiokol Chemical has been awarded a research and development contract** for work on the Army's Nike Hercules booster engine . . . **The first commercially successful method of applying pure polyethylene to steel surfaces** as a lining material for tanks, pipes and valves, is claimed by Tank Lining Corp., Pittsburgh, Pa.

—Bus.-Management Ed.

Heat Transfer at the Edgewater Beach

2nd National Heat Transfer Conference will be held at Chicago's world-famous Edgewater Beach Hotel August 18-20, will feature dual theme of theory and down-to-earth practice—AND a major Heat Transfer Exhibit by leading companies in the fields.

Two societies–A.I.Ch.E. and A.S.M.E. both leaders in the field of heat transfer, are calling all engineers to Chicago for this major heat transfer meeting.

Two major parts make up the conference–the heat transfer technical program, and the heat transfer Exhibit. On display will be the latest in heat transfer equipment, media, and ancillaries.

Two themes will be emphasized in the technical program–the latest in research and basic theory, and the latest in practice and industrial applications.

This is August, the Edgewater Beach is a world famous resort hotel with a swimming pool, golf course nearby, a summer theater playing "Uncle Willie", baseball day or night, and all the recreation facilities of the country's second largest city. Accommodations are at the Edgewater beach for you and the family, or, if you are economizing, there will be dormitory rooms at Northwestern U. Transportation to hotel is by "El" at 38¢ each way.

Al Foust of A.I.Ch.E. and Sig Kopp of A.S.M.E. have gathered one of the best technical programs on heat transfer.

Here is a first-rate chance to combine the important problems of heat transfer with a vacation for yourself and the family in Chicago--at the Edgewater Beach August 18-20.

EXHIBITORS AT HEAT TRANSFER CONFERENCE

OPEN HOURS: Mon.-Tues. 9-5; Wed. 9-3.

Company	Booth
American Heat Reclaiming Corp.	37 & 38
Baker Perkins, Inc.	35
Bendix Computer Div. Bendix Aviation	1 & 2
Cardox Corp., CO_2 Division	10
Curtiss-Wright Corp.	4
Dow Chemical Co.	25
The Kontro Co., Inc.	22
Monsanto Chemical	32
MSA Research Corp.	12
National Carbon Co.	28
Parks-Cramer Co.	17
Republic Steel Corp., Steel & Tubes Div.	15
Royal McBee Corp.	21
Thermon Manufacturing	13
The Whitlock Manufacturing Co.	26 & 27
Wolverine Tube Div. Calumet & Hecla	19

SUNDAY, AUGUST 17

8-10 P.M.—Cocktail party.

MONDAY, AUGUST 18

9:30 A.M.—12 Noon.

SESSION—I, A. C. Mueller, A.I.Ch.E., chmn.: W. E. Hammond, A.S.M.E., co-chmn.

Heat Transfer and Fluid Friction During Flow Across Banks of Tubes-VII—Fluid By-Passing Between Tube Bundle and Shell, O. P. Bergelin, U. of Dacca, E. Pakistan, K. J. Bell, Case Inst., Cleveland, and M. D. Leighton, U. of Del., Newark, Del.

The results presented include isothermal, heating, and cooling runs in both the laminar and turbulent regimes for two bank geometries with various bank-to-shell clearances. Methods of generalizing the results for commercial exchanger design are considered.

Local Shell-Side Heat Transfer Coefficients in the Vicinity of Segmental Baffles in Tubular Heat Exchangers, M. S. Gurushankariah and J. G. Knudsen, Ore. State Coll., Corvallis.

The data are presented in picture form which enabled the drawing up of a schematic diagram of the flow pattern in the baffle space, heat transfer coefficients were studied in detail.

Description and Experimental Results of Two Regenerative Heat Exchangers, E. K. Dabora, M. P. Moyle, R. Phillips, J. A. Nicholls, and P. L. Jackson, U. of Mich., Ann Arbor.

Two pebble-type regenerative heat exchangers designed to produce stagnation temperatures of the order of 2500° R. at pressures of the order of 1000 lbs./sq. in. in experiments designed to achieve a standing detonation wave.

Two-Phase Pressure Drop for Horizontal Cross-flow Through Tube Banks, J. E. Diehl, C. H. Unruh.

SESSION—II, G. M. Dusinberre, A.S.M.E., chmn.; C. H. Gilmour, A.I.Ch.E. Co-chmn.

Radiant Heat Transfer in Sheet Annealing Furnaces, H. T. Bates, U. of Nebraska, T. Utsumi, Montana State.

Equations for radiant heat transfer should be available for modern applications, are developed here.

Radiative and Conductive Heat Transfer in a Quiescent Gas-Solid Bed of Particles: Theory and Experiment, P. B. Hill, Brookhaven, and R. H. Wilhelm, Princeton U.

A theory for transfer in such systems is generalised to include planar, spherical, and cylindrical bed geometries.

Heat and Mass Transfer Coefficients for the System Air-Water in a Perforated Plate Column, W. S. Stewart and R. L. Huntington, U. of Okla.

A search of the literature did not yield any information on heat transfer in perforated plates, and very little on mass transfer. This study is intended to fulfill this need.

Emissivity Measurements of Industrial Surfaces Due to Thermal Radiation, M. N. Aref.

12 Noon—Problem Solving Luncheon.

2-5 P.M.

SESSION—III, N. P. Altman, A.I.Ch.E., chmn.: K. A. Gardner, A.S.M.E., co-chmn.

Heat Transfer and Pressure Drop of Air in Forced Convection Across Triangular Pitch Banks of Finned Tubes, D. J. Ward, Universal Oil Products, and E. H. Young, U. of Mich.

A study of this type of system containing smooth, integral, helically-finned tubes with air drawn by forced convection in crossflow through the banks.

Engineering Method for Determining a Design Envelope for Air-to-Air Cross-Flow Heat Exchanger, W. T. Shatzer.

Optimum Air-Fin Cooler Design, D. Q. Kern, Donald Q. Kern Associates. A theoretical approach to design.

Calculation of Transients in a Cross-Flow Heat Exchanger, G. M. Dusinberre.

Russian Vocabulary for Heat Transfer Literature, (Mrs.) P. P. Buckland.

SESSION—IV, A. S. Foust, A.I.Ch.E., chmn.; J. P. Hartnett, A.S.M.E., co-chmn.

Film Coefficients for Heat Transfer to Liquid Drops, E. R. Elzinga, Jr., and J. T. Banchero, U. of Mich.

Three drop models were adopted to explain the transfer of heat inside the drop, and these were used in conjunction with the experimental data to determine the heat transfer coefficients outside the drops.

A correlation of Rotary Drum Cooler-Flaker Heat Transfer, K. L. Mai, Shell Chemical, Houston.

A theoretical mathematical expression is given which effectively correlates rotary drum cooler-flaker design and operating variables.

Numerical and Machine Solutions of Transient Heat Conduction Problems Involving Melting or Freezing—Part I, W. D. Murray, F. Landis.

Experimental Forced Convection Heat Transfer with Adiabatic Walls and Internal Heat Generation in a Liquid Metal, G. L. Muller.

Heat Transfer Coefficients Observed in Small Sodium Exchangers, S. C. Hyman.

TUESDAY, AUGUST 19

9:30 A.M.—12 Noon.

SESSION—V, S. Kopp, A.S.M.E., chmn; S. W. Churchill, A.I.Ch.E., co-chmn

The Design of Heating Coils for Storage Tanks, D. Stuhlberg.

The Pressure Drop of Condensing Steam in Horizontal Pipes, R. J. Dunn, D. Stuhlberg.

Heat Exchanger Maintenance as Influenced by Design and Economic Factors, G. T. Atkins and N. O. Felps.

Heat Transfer Principles Applied to Practical Production Heating Problems, C. P. Mann, Selas Corp. of America.

How analysis of heat transfer problems leads to the selection of heating methods yielding optimum heating rates, industrial examples.

SESSION—VI, J. S. Knudsen, A.I.Ch.E., chmn.; J. P. Wachunas, A.S.M.E., co-chmn.

Heat and Mass Transfer from a Rotating Disk, F. Kreith, J. H. Taylor, and J. P. Chong, Lehigh U.

Heat transfer by convection from a rotating body is of importance in the thermal analysis of rotating components of various types of machinery.

Transient Heat Conduction in Elliptical Plates and Cylinders, E. T. Kirkpatrick and W. P. Stokey.

Heat Transfer

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Transient Heat Conduction in Annular Fins of Uniform Thickness, A. J. Chapman, Rice Inst.
Dimensionless equations are presented in a convenient graphic form for a cooling fin which is initially at the same temperature as the surroundings and is suddenly heated at its inner radius.

The Radial Heat Flux, S. W. Churchill and R. E. Balzhiser, U. of Mich.
The ratio of radial heat flux at any radius, to the radial heat flux at the wall, provides insight into the transfer mechanism which can be used for calculating the temperature field and heat transfer coefficient from total conductivity for either laminar or turbulent flow.

A Note on Latent Heat in Digital Computer Calculations, G. M. Dusinberre

2:00-5:00 P.M.

SESSION—VII, G. E. Leppert, A.S.M.E., chmn.; M. T. Cichelli, A.I.Ch.E., co-chmn.

The Prediction of Surface Temperatures at Incipient Boiling, S. G. Bankoff, Rose Poly. Inst.
Superheat required for bubble nucleation with respect to surface conditions, is considered.

Design of High Velocity Forced Circulation Reboilers For Fouling Service, W. A. Chantry and D. M. Church, Shell Chem. Corp.
Reboilers can now be designed by a procedure utilizing an economic balance to arrive at optimum tube velocity.

Generalized Correlation of Boiling Heat Transfer, S. Levy.

Heat Transfer to Boiling Liquid: Mechanism and Correlation, K. Forester and R. Grief.

Heat Transfer to Boiling Freon in a Vertical Tube, H. L. Foltz, R. O. Murray, Goodyear.
Heat transfer rates from condensing steam to boiling Freon 114 were measured in vertical tubes to determine where the assumption of uniform heat flux could be safely used and how tube length, tube diameter, flow rates, pressure, and temperature difference affect uniformity.

SESSION—VIII, D. L. Katz, A.I.Ch.E., chmn.; R. H. Norris, A.S.M.E., co-chmn.

Heat Transfer in a Vacuum Tube Amplifier, M. Goldberg.

The Use of Steady State Electrical Network Analysis in Solving Heat Flow Problems, A. D. Kraus.

The Effectiveness of a Transistor Cap as a Heat Dissipator, A. D. Kraus.

Natural Convection in Horizontal Liquid Layers, I. E. Schmidt and P. L. Silveston, Esso Res. & Eng.
Heat transfer through a horizontal liquid layer bounded on top by a cold surface and on bottom by a heated surface was measured. Results were correlated by a plot using the dimensionless numbers.

7 P.M.—Banquet.
Speaker: T. S. Chilton, DuPont.

WEDNESDAY, AUGUST 20
9:30 A.M.—12 Noon.

SESSION—IX, M. Tribus, A.S.M.E., chmn.; D. Q. Kern, A.I.Ch.E., co-chmn.

Bubble Growth Rates in Highly Sub-cooled Nucleate Boiling, S. G. Bankoff and R. D. Midesell, Rose Polytech. Inst.
Bubble trajectory mechanism parameters were computed and the relationship of heat flux to turbulent and convective heat flow were postulated.

Active Sites for Nucleate Boiling, H. B. Clark, DuPont, P. S. Strenge, Eastman Kodak, and J. W. Westwater, Univ. of Illinois.
Photography during and after nucleate boiling was used to identify active bubble-producing sites.

Void Volumes in Sub-Cooled Boiling Systems, P. Griffith, J. A. Clark, W. M. Rohsenow.

Nucleate Boiling—A Correlation, C. H. Gilmour, Union Carbide Chem. Co.

A new equation is proposed for the correlation of existing nucleate boiling data for use in the design of equipment in which vaporization occurs. The equation has been used successfully in the design of hundreds of vaporizers and reboilers.

SESSION—X, E. P. Lynch, A.I.Ch.E., chmn.; S. Ostrach, A.S.M.E., co-chmn.

The Effects of Superimposed Forced and Free Convection in Horizontal and Vertical Rectangular Ducts, M. Altman and F. W. Staub, G.E.

Test data are reported for stationary turbine models of both radial and axial cooling passages. Effects of varying wall temperature distributions and entrance conditions are considered.

Heat Transfer From Isothermal Flat Plates—An Extension of Pohlhausen's Solution to Low and High Prandtl Number Fluids, F. D. Fisher and J. G. Knudsen, Ore. State Coll.

Pohlhausen's integral form solution is rearranged for easy evaluation for low Prandtl number fluids less than 0.15.

Free Convection, Forced Convection and Acoustic Vibrations in a Constant Temperature Vertical Tube, T. W. Jackson, W. B. Harrison and W. C. Boteler.

Transient Heat Transfer for Forced Convection in the Thermal Entrance Region of Flat Ducts, R. Siegel and E. M. Sparrow.

The Effect of Natural Convection Upon Heat Transfer At High Reynolds Numbers, H. T. Bates and A. I. Munaim, Univ. of Nebraska.

An empirical analysis of experimental data for heating water inside horizontal tubes, in which natural convection is taken into account.

2:00-5:00 P.M.

SESSION—XI, S. G. Bankoff, A.I.Ch.E., chmn.; W. M. Rohsenow, co-chmn.

Mechanically-Aided Heat Transfer, D. Q. Kern, D. Q. Kern Assoc.; H. J. Karakas, Rodney Hunt Mach. Co.

Equations for the design of heat transfer devices with moving parts, which implement phase changes to and from viscous Newtonian and non-Newtonian fluids.

Heat Transfer Aspects of Concentrated Milk in a Falling Film Evaporator, J. F. Keville, Carrier Corp.

Falling film boiling heat transfer coefficients have been correlated with respect to the physical properties of the concentrated milk and other liquids, and the geometry of the evaporator. Two dimensionless equations have been derived to cover a wide range of operating conditions.

A Preliminary Study of Boiling Burnout Heat Fluxes for Water in Vortex Flow, W. R. Gambill and N. D. Greene, ORNL.

The new case of sub-cooled water in forced-convection source-vortex flow through electrically heated horizontal tubes of small diameter was studied, and data correlated empirically.

Performance of Vaporizers—Analysis of Plant Data, C. H. Gilmour, Union Carbide Co.

SESSION—XII, S. Kezios, A. S. M. E., chmn.; T. B. Drew, A.I.Ch.E., co-chmn.

Condensing Heat Transfer Within Horizontal Tubes, W. W. Akers, Rice Inst.; H. A. Deans, Princeton U. and O. K. Crosser, U. of Okla.

Condensing heat transfer coefficients for propane and Freon 12 were measured over a wide range of conditions.

Forced Convection, Local Boiling Heat Transfer in Narrow Annuli, L. Bernath, DuPont, and W. Begell, Columbia U.

Heat transfer data in the region of fully developed local boiling have been collected, analyzed and correlated. Results permit prediction of wall super-heat.

Methods of Improving Heat Transfer in Evaporators of Small Thermocompression Sea-Water Stills, J. A. Eibling, Battelle, and D. L. Hyatt, Surface Combustion Corp.

Results of studies of the effects of forced circulation of the evaporating water, and of film and dropwise condensation of steam, on heat transfer at the low Δ T's associated with the operation of thermocompression stills.

Heat Transfer to Water in Thin Rectangular Channels, S. Levy, R. A. Fuller, R. O. Niemi.

Landau—West Germany

Continued from page 68

cope with the increasingly complex physico-chemical nuclear-mechanical problems of the future *(15, 16)*.

In the United States this could well emerge from the present doctorate in chemical engineering by gradual evolution along the following lines: More science and humanities would be taught in the primary and secondary schools; the four-year undergraduate chemical engineering curriculum, now well defined, would largely continue, with further reductions in such courses as shop practice, analytical chemistry, and increasing stress on mathematics and humanities; in the graduate curriculum there would be more mathematics, statistics, physics, chemistry, and basic engineering sciences as well as chemical and nuclear engineering theory, probably at the expense of some of the thesis work which is increasingly unlike actual research practice in industry. American chemical engineering curricula of the future should include more mechanical engineering training and discipline, and in this way will tend to assume some of the aspects of the process engineer's training in West Germany.

5. American chemical engineering can help other countries in a more rapid increase in their standard of living (as it has so signally done in the United States), and America can benefit from the viewpoints of other countries if such could be expressed in interchanges and meetings of American, European, Asiatic and other technologists. Such meetings have been held on a limited scale before, but without a sufficiently broad participation to permit a really rounded presentation.

ACKNOWLEDGMENT

The help of R. S. Davis and A. W. Gessner, of the Scientific Design Company, Inc., is gratefully acknowledged, as is also the invaluable cooperation of many German industrial figures who must remain anonymous.

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future meetings

1958—A.I.Ch.E.

• Evanston, Ill., August 18-21, 1958. *A.I.Ch.E.-A.S.M.E. Heat Transfer Conference.* Edgewater Beach Hotel. Tech. Prog. Chmn.: A. S. Foust, Chem. Eng. Dept., Lehigh University, Bethlehem, Pa. For complete details of program see p. 111.

• Salt Lake City, Utah, Sept. 21-24, 1958, Hotel Utah. *A.I.Ch.E. National Meeting.* For details see p. 98.

• Cincinnati, Ohio, December 7-10, 1958. Netherland Plaza Hotel. *A.I.Ch.E. Annual Meeting.* Genl. Mtg. Chmn.: T. B. Wiehe, Schenley International. Tech. Prog. Chmn.: A. C. Brown, Emery Industries, Inc. June & Long Sts., Ivorydale, Ohio. *Pollution Control by In-Plant Measures*—C. Fred Gurham, Dept. of Chem. Eng., Michigan State U., East Lansing, Michigan. *A.I.Ch.E. Research on Bubble Cap Tray Efficiency*—W. G. Schreiner, M. W. Kellogg Co., 711 Third Ave., New York 17, N. Y. *High-Speed Photography in Chemical Engineering*—J. W. Westwater, William Albert Noyes Laboratory, Univ. of Illinois, Urbana, Ill. *Kinetics & Rate Processes*—H. E. Hoelscher, Dept. of Chem. Eng., Johns Hopkins Univ., Baltimore 18, Md. *Reprocessing of Fluid Reactor Fuels*—O. E. Dwyer, Chem. Eng. Div., Brookhaven National Laboratory, Upton, L.I., N. Y. *The Application of Computers to Heat and Mass Transfer Problems*—J. M. Smith, Northwestern Univ., Evanston, Ill. *Low Temperature Processing*—C. McKinley, Air Products, Inc., Allentown, Pa. *Scale-up from Pilot Plant to Plant*—D. B. Coghlan, Foote Research and Development Laboratories, Berwyn, Pa., R. A. Schulze, DuPont Chambers Works, Jackson Labs., Penns Grove, N. J. *Guideposts in Long Range Planning*—H. E. Wessel, Virginia-Carolina Chemical Corp., 401 Main St., Richmond, Va. *Processing of Irradiated Fuels—A Challenge for the Future*—J. L. Schwennesen, A.E.C., P.O. Box 1221, Idaho Falls, Idaho. *Spray Mechanisms*—J. F. Tourtellotte, Swenson Evaporator Co., 18505 James Couzens Highway, Detroit, Mich. *Air-Cooled Heat Exchange*—W. W. Akers, Dept. of Chem. Eng., Rice Institute, Houston, Texas. *Education in Process Control*—T. J. Williams, Monsanto Chem. Co., 1700 S. Second St., St. Louis 4, Mo. *General Papers*—W. M. Licht, Dept. of Chem. Eng., Univ. of Cincinnati, Cinn., Ohio. *Education and Accreditation*—C. C. Monrad, Chem. Eng. Dept., Carnegie Inst., Pittsburgh 13, Pa. *Recent Trends in Chem. Engg.*
Deadline for papers: August 7, 1958.

• Galveston, Texas, Oct. 3, 1958. Moody Center. *13th Annual Technical Meeting. So. Texas sect. A.I.Ch.E.* Prog. Chmn.: C. L. Umholtz Humble Oil, Baytown, Tex.

1958—NON-A.I.Ch.E.

• Geneva, Switzerland, Sept. 1-13, 1958. *Second International Conference on the Peaceful Uses of Atomic Energy.*

• Philadelphia, Sept. 15-19, 1958. Philadelphia Convention Hall. *13th annual instrument-automation conf. & exhibit.* Inst. Soc. of America. For info: W. H. Kushnick, ISA, 313 Sixth Ave., Pitts., Pa.

1959—MEETINGS—A.I.Ch.E

• Atlantic City, N. J., March 15-18, 1959. *A.I.Ch.E. National Meeting.* Chalfonte Haddon Hall Hotel. Gen. Chmn.: J. D. Stett, Dept. Mech. Eng., Rutgers Univ., New Brunswick, N. J. Tech. Prog. Chmn.: N. Morash, Natl. Lead Co., P.O. Box 58, So. Amboy, N J. *Recent Advances in Plastic Materials of Construction*—M. F. Gigliotti, Monsanto Chem. Co., Plastic Div., Springfield, Mass. *Business & Technology*—J. Happel, NYU. *Theoretical and Laboratory Work on Liquid-liquid Extraction*—R. E. Treybal, NYU, Univ. Heights 53, N. Y. *Laboratory and Pilot Plant Techniques*—G. W. Blum, Goodyear Tire & Rubber Co., Akron, Ohio. *Missiles, Rockets & Satellites*—G. C. Szego, Gen. Elect., Aircraft & Gas Turbine Div., Cinn. 15, Ohio. *General Papers* (2 sessions), J. Joffe, Newark Coll. of Eng., 367 High St., Newark 2, N. J. and E. C. Johnson, Dept. of Chem. Eng., Princeton U., Princeton, N. J. *Computer Control of Processing Units*—J. M. Mosley, Johns Hopkins Hospital, Baltimore 5, Md. *Startup of New Chemical Plants*—M. L. Nadler, DuPont, Penns Grove, N. J. *Care and Feeding of Executives*—J. S. Wilson, Heidrick & Struggles, 20 No. Wacker Dr., Chicago 16, Ill. *Mechanics of Fluid-Particle Systems*—S. K. Friedlander, Johns-Hopkins Univ., Balt., Md. *Process Data & Design Methods for Nuclear Fuel Recovery*—C. E. Stevenson, Rsch. Dir.,

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future meetings

from page 116

P.O. Box 1259, Idaho Falls, Idaho. *Thermodynamics of Phase Equilibria*—E. M. Amick Jr., Chem. Eng. Dept., Columbia U., New York 27, N. Y. *Market Research & the Chemical Engineer*—William Copulski, Grace R&D Co., 3 Hanover Sq., New York 4, N. Y. *Thermal Stability of Jet and Rocket Fuels*—C. J. Marsel, NYU, Univ. Heights, New York, N. Y.
Deadline for papers: November 16, 1958.

• Cleveland, O. April 5-10, 1959. *1959. Nuclear Congress. Co-sponsored by A.I.Ch.E. and others.* A.I.Ch.E. representative: E. B. Gunyou, Mngr. Nuclear Pr. Koppers Co., Koppers Bldg., Pitts. 19, Pa.

• Kansas City, Missouri, May 17-20, 1959. Hotel Muehlebach. *A.I.Ch.E. National Meeting.* Gen. Chmn.: F. C. Fowler, Consulting Chem. Engr. 7515 Troost Ave., Kansas City, Mo. Tech. Prog. Chmn.: Fred Kurata, Chem. Eng. Dept., Univ. of Kansas, Lawrence, Kansas. *Reaction Kinetics*—R. R. White, Dept. of Chem. Eng., Univ. of Michigan, Ann Arbor, Mich. *How to Become a More Proficient Technical Engineer. Heavy Chemicals*—N. J. Ehlers, Columbia-Southern Chem, Corp., 1 Gateway Center, Pitts. 22, Pa. *Petrochemicals*—G. E. Montes, Nat'l. Petrochemical Corp., Tuscola, Ill. *International Licensing and Collaboration*—R. Landau, Scientific Design Co., 2 Park Ave., New York, N. Y. *General Papers* (2 sessions), J. O. Maloney, Univ. of Kansas, Lawrence, Kan. and Merk Hobson, Univ. of Nebraska, Lincoln, Nebr. *Non-Equilibrium Fluid Mechanics*—M. J. Rzasa, Cities Services Res. Lab., P. O. Box 402, Cranbury, N. J. *Role of Wetting and Capillarity in Fluid Displacement Processes*—C. S. Kuhn, Magnolia Petroleum Co., 907 Thomasson Dr., Dallas, Tex. *Thermodynamics of Jet & Rocket Propulsion*—G. C. Szego, Gen. Elect. Aircraft & Gas Turbine Div., Cinn. 15, Ohio. *Computers and Pipelines*—R. L. McIntire, The Datics Corp., 600 Camp Bowie Blvd., Fort Worth, Texas.
Deadline for papers: January 17, 1959.

• St. Paul, Minn., Sept. 27-30, 1959. Hotel St. Paul. *A.I.Ch.E. National Meeting.* Gen. Chmn.: W. M. Podas, Asst Rsch Dir., Economics Lab., Guardian Bldg., St. Paul, Minn. Tech. Prog. Chmn.: A. J. Madden, Jr., Univ. of Minn.
Mixing—J. Y. Oldshue, Mixing Equip. Co., Inc., P. O. Box 1370, Rochester 3, N. Y. *Size Reduction*—E. L. Piret, Chem. Eng. Dept., Univ. of Minnesota, Minneapolis 14, Minn.

• San Francisco, Calif., December 6-10, 1959. *A.I.Ch.E. Annual Meeting.* Gen. Chmn.: Mott Souders, Jr., Shell Development Co., 4560 Horton St., Emeryville 8, Calif. Tech. Prog. Chmn.: C. R. Wilke, Div. of Chem. Eng., Univ. of Calif., Berkeley, Calif. *Process Dynamics*—E. F. Johnson, Dept. of Chem. Eng., Princeton Univ., N. J. *Secondary Oil Recovery Methods; New Oil Sources—Shale, Gilsonite, Tar Sands; Financing in the Chemical Industry; Raw Materials for the Chemical Industry; Turbulence and Turbulent Mixing; High Temperature: Thermodynamics, Reactions, Kinetics; Devices, and Materials-Operations Research; Electro-chemical Engineering-Process Design; Fundamental Aspects of Chemical Engineering in the Pulp and Paper Industry.*
Deadline for papers: August 6, 1959.

1960—MEETINGS—A.I.Ch.E.

• Atlanta, Ga. Feb. 21-24, 1960. *A.I.Ch.E. National Meeting.* Tech. Prog. Chmn.: Fred Bellinger, Ga. Inst. of Techn., 225 North Ave., N.W. Atlanta 13, Ga. Mexico City, Mex. *National Meeting,* Tulsa, Okla. *National Meeting.* Washington, D.C. Dec. 4-7, 1960. *A.I.Ch.E. Annual Meeting.* Tech. Prog. Chmn. not named yet.

Unscheduled Symposia

Correspondence on proposed papers is invited. Address communications to the Program Chairman listed with each symposium below.
Chemical Engineering Process Dynamics as They Affect Automatic Control: David M. Boyd, 315 Ridge Ave., Clarendon Hills, Ill.
The Threatened Imbalance Between Chlorine and Alkali in American Chemical Industry: Zola G. Deutsch, Deutsch & Loonam, 70 E. 45th St., New York City 17.
Computers in Optimum Design of Process Equipment: Chen-Jung Huang, Dept. of Chem. Eng., Univ. of Houston, Cullen Blvd., Houston 4, Texas.

continued on page 125

Prepared by U. S. Industrial Chemicals Co.

U.S.I. CHEMICAL NEWS

July ★ A Series for Chemists and Executives of the Solvents and Chemical Consuming Industries ★ 1958

Urethan Applications Grow In Drug, Chemical Fields

Ethyl carbamate, more commonly known as Urethan, has become a useful chemical tool with a wide variety of uses since it was first produced in this country over 20 years ago. Urethan's applications now range from cancer therapy to the manufacture of plasticizers — and useful new reactions are continually being found.

In the pharmaceutical field, Urethan is now employed in the production of tranquilizers, and in the synthesis of many drugs. Its medical applications include the treatment of leukemia and other forms of cancer. Urethan is a mild hypnotic and sedative; is also reported to enhance the effectiveness of penicillin and streptomycin, and to increase the activity of certain enzymes.

Plasticizer producers use Urethan as a gelatinizing agent for cellulose acetate and cellulose nitrate. Cosmetic makers find it an excellent solvent in astringent preparations and hair dyes. Diazo paper manufacturers incorporate it into the light-sensitive layer to yield bright, stable prints.

Urethan is the ethyl ester of carbamic acid and has the chemical formula

$$H_2N-\overset{\displaystyle O}{\overset{\|}{C}}-O-C_2H_5$$

As a chemical intermediate, it reacts with many organic and inorganic compounds to form end products or other intermediates of commercial importance in the dyestuffs, plasticizer, food and drug fields among others.

U.S.I., pioneer producer of Urethan, has a wealth of experience with this wide-spectrum chemical, and can supply information or technical help on applications and reactions.

Polyethylene Closures for Drums Now Self-Venting

Used on U.S.I. Alcohol Drums

A leak-proof, tamper-proof, all-polyethylene closure for containers carrying liquids—trade-named FlexSpout* — now has a self-venting feature which eliminates the need for other separate vents on shipping containers. The improved spout

MORE

*® Rieke Metal Products, Auburn, Ind.

Self Venting FlexSpout on U.S.I. Pure Ethyl Alcohol, USP, 5-gallon drum being pulled up into pouring position via new bail on reseal cap.

Promising New Sodium Treatment Developed for Bonding Teflon

Sodium-Naphthalene-Solvent Treatment Claimed More Convenient Than Earlier Teflon Preparation for Strong Bonding to Metals, Rubber and Plastics

A new surface treatment has been developed for joining fluorinated resins such as Teflon to other materials. The resulting ease of bonding will undoubtedly increase Teflon utilization as a corrosion-resistant lining for process equipment and vessels, as a bearing material, and in fluid seals.

The new process, described in U.S. Patent 2,809,130, requires only conventional ventilation, and uses treating solutions that can be stored for long periods. Its advantages over the sodium-ammonia solution surface treatment should bring the new process into wide application for preparing Teflon for adhesion to metals, rubber and plastics.

Bond Strengths Are High

It is reported in the patent that peel tests were made on an epoxy cement bond between the treated Teflon and a phenol-formaldehyde resin — and that the bond was stronger than the Teflon itself. Similar results were obtained in joining Teflon to metal and rubber with a chlorinated rubber adhesive.

How It Is Done

The Teflon surface is bathed at room temperature with a sodium-naphthalene complex dissolved in a solvent such as dimethyl glycol ether. When the surface turns a grey-brown, it is ready for bonding to other materials. A wide variety of common adhesives can be used, including chlorinated rubber types, resorcinol formaldehyde cements, phenolic types, and epoxies.

Preparation of Treating Solutions

The patent gives a specific example of solution preparation as follows: a liter of a molal solution of naphthalene in a dimethyl glycol ether solvent under a nitrogen blanket is

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Largest All-Nuclear Power Plant to Contain 44 Miles Of Zirconium Tubing

At Dresden, Illinois, a 180,000 KW all-nuclear power station is being constructed which will contain in its reactor core almost 44 miles of tubing made from zirconium. This Commonwealth Edison boiling water reactor plant will be the largest all-nuclear station in the U.S. when it begins operation in mid-1960.

The tubing is made of reactor-grade Zircaloy-2 and is used as a container for UO_2 fuel pellets. It is to be given special pressure, sonic and corrosion tests, to insure that it

Sphere to house reactor, and turbine building, for Commonwealth Edison's Dresden, Ill., power plant — to be country's largest all-nuclear station when completed in 1960. Reactor will contain 44 miles of zirconium tubing. (photo courtesy General Electric)

meets the rigid tolerances established for this type of tubing.

Zirconium metal has an extremely low nuclear cross-section — allowing free passage of neutrons—and makes an ideal cladding material for uranium because it offers minimum interference to the fission process, is corrosion and heat resistant, and structurally strong.

This zirconium tubing order, the largest ever placed, is being processed by Mallory-Sharon Metals Corporation (owned ⅓ by U.S.I.), world's largest producer of special metals such as titanium, hafnium, zirconium, tantalum and columbium. The company uses a U.S.I. sodium reduction manufacturing process which offers advantages in both economy and product quality.

Another ISOSEBACIC® *Acid Patent for U.S.I.*

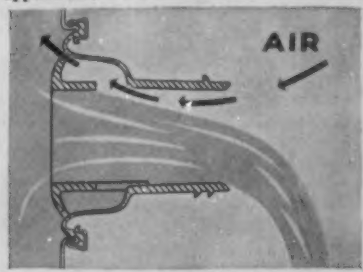
U.S. Patent No. 2,822,389 on the separation of C-10 dicarboxylic acids has been granted to U.S.I. It is the ninth patent U.S.I. has obtained on its manufacturing process for ISOSEBACIC acid — a new intermediate for the plastics industry. The material is a mixture of three C-10 dibasic acids — 2-ethylsuberic acid, and 2,5-diethyladipic acid, and sebacic acid.

A plant to produce ISOSEBACIC acid in commercial quantity is now being completed at U.S.I.'s major chemical complex in Tuscola, Illinois. Potential applications of the new intermediate include the manufacture of plasticizers, ester lubricants, alkyds, polyamides, polyurethanes, reinforced plastics and in chemical synthesis.

July ★ **U.S.I. CHEMICAL NEWS** ★ 1958

CONTINUED *Polyethylene Closures*

also eliminates liquid surge or "glug" in pouring. It is claimed that there is no waste or spillage, since the closure will vent in any pouring position, and a controlled flow—large or small—can be maintained. Patent has been applied for.



Cross-section of Self Venting FlexSpout closure.

The new FlexSpout, like the old, is normally recessed during shipping and storage and can be extended for pouring. Addition of a bail to the polyethylene cap, however, makes it easy to pull the spout up into pouring position.

This improved closure will soon be on all 5-gallon containers in which U.S.I. ethyl alcohol is shipped. It offers greater convenience in handling and pouring.

CONTINUED *Teflon*

reacted with metallic sodium. Formation of the sodium-naphthalene complex is indicated by the appearance of a greenish color, at which point the Teflon is immersed.

Other investigators have cited the use of finely divided sodium dispersed in xylene or white oil. Preparation and handling are described in a U.S.I. brochure, "Sodium Dispersions" which may be obtained on request.

Those who will be employing metallic sodium for the first time when applying this treatment will find valuable information in U.S.I.'s 40-page book, "Handling Metallic Sodium on a Plant Scale." The book is available from U.S.I. without charge.

Cabot's Extrafine Silica Now Made at Tuscola, Ill.

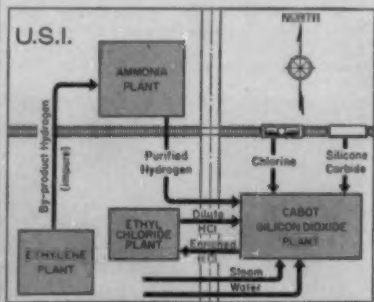
New Plant is Integrated with U.S.I. Production Facilities

A five million pound per year plant for the production of finely-divided silicon dioxide is now onstream at Tuscola, Illinois. Godfrey L. Cabot, Inc. has been importing the product, Cab-O-Sil*, from Germany since 1952. The new Cabot plant is the first in this country to make silica by the German process.

Cab-O-Sil's unique properties are said to derive from this method of manufacture which involves the vapor-phase hydrolysis of silicon tetrachloride in a hot hydrogen environment. The silicon dioxide produced has a particle diameter of 15-20 millimicrons, surface area of 175-200 square meters per gram, purity of 99-99.7%. It has found application in reinforcing rubber polymers, producing stable lubricating greases, coating reproduction papers, adjusting viscosity of paints and inks, and controlling flow properties of a wide variety of industrial powders and liquids.

Cabot chose Tuscola as a plant site because of its economic advantages. Located near U.S.I.'s ammonia and ethyl chloride facilities, the new Cabot plant utilizes raw materials supplied by the U.S.I. processing units, and the U.S.I. ethyl chloride plant uses byproduct hydrogen chloride from Cabot.

*® Godfrey L. Cabot, Inc.



Flowsheet showing interrelation of U.S.I. and Cabot plants at Tuscola, Illinois.

TECHNICAL DEVELOPMENTS

Information about manufacturers of these items may be obtained by writing U.S.I.

Glass acid bulbs for accurate quantitative analysis of fuming acids, toxic or volatile chemicals, etc., can now be purchased in commercial quantity. They are said to be of controlled diameter, weight, uniformity of wall thickness; can be made in any desired size. **No. 1370**

Portable kit for field testing of non-fat milk solids is now available. Permits quick determination of solids content before milk goes to dairy. Consists of portable water bath, milk sample tubes, lactometers; weighs 40 lbs. **No. 1371**

Antibacterial compound just developed is claimed nontoxic, nonirritating, noncorrosive, odorless, tasteless, water soluble. This complex silver compound is suggested for liquid soaps, toilet goods, other similar products. **No. 1372**

New pump eliminates contact of moving parts with fluid handled. Intake and outlet consists of one flexible tube passing through pump body and acted upon by kneading action of double rotor. Handles corrosives and abrasives. **No. 1373**

Molybdenum pentachloride — active catalyst for chlorinating aromatics, Friedel-Crafts alkylations and like reactions — can now be obtained in semiworks quantities. Also "plates" molybdenum when reduced by hydrogen. **No. 1374**

New needle-and-glass syringe combination packed in sterile polyethylene bag is now available. Entire unit is designed to be discarded after use. Glass barrel unaffected by solvents during long contact with parenteral fluids. **No. 1375**

All phases of the flexographic printing process are covered in a new, revised, updated edition of an older book. Now on sale, new volume includes sections on copy preparation and halftone printing by flexography. **No. 1376**

New centrifugal filming machine for sterilizing sensitive biological fluids and producing high-potency vaccines by ultraviolet irradiation now in production. Suggested for polio vaccines, blood plasma, liquid foods. **No. 1377**

Fiber glass finishing agent which establishes a better bond between fibers and resins is now available in semiworks quantity. Reported to give better wet and dry strengths to polyester, epoxy, melamine, phenolic laminates. **No. 1378**

For liquid oxygen systems, new thread sealing compound is now available. Is specifically formulated for negligible impact sensitivity, is claimed to have approval of several rocket motor manufacturers. **No. 1379**

PRODUCTS OF U.S.I.

HEAVY CHEMICALS

Sodium, Metallic: cast solid in tank cars, steel drums, pails; bricks in barrels, pails.

Sodium Peroxide, Sodium Sulfite, Sodium Sulfate

Ammonia, Anhydrous: commercial & refrigeration. Tank cars or tank wagons.

Ammonium Nitrate, Nitric Acid, Nitrogen Fertilizer Solutions

Phosphatic Fertilizer Solution: wet process phosphoric acid.

Sulfuric Acid: all strengths, 60 Baume to 40% Oleum. Also Electrolytic grade to Federal specifications. Tank cars or tank wagons.

Caustic Soda, Chlorine

OTHER PRODUCTS

PETROTHENE® Polyethylene Resins

Pharmaceutical Products: DL-Methionine, N-Acetyl-DL-Methionine, Urethan USP, Riboflavin USP, Intermediates.

Alcohols: Ethyl (pure and all denatured formulas); Proprietary Denatured Alcohol Solvents SOLOX®, FILMEX®, ANSOL® M, ANSOL PR.

Organic Solvents and Intermediates: Normal Butyl Alcohol, Amyl Alcohol, Fusel Oil, Ethyl Acetate, Normal Butyl Acetate, Diethyl Carbonate, DIATOL®, Diethyl Oxalate, Ethyl Ether, Acetone, Acetoacetanilide, Acetoacet-Ortho-Chloranilide, Acetoacet-Ortho-Toluidide, Ethyl Acetoacetate, Ethyl Benzoylacetate, Ethyl Chloroformate, Ethylene, Ethyl Sodium Oxalacetate, Sodium Ethylate, ISOSEBACIC® Acid, Sebacic Acid, Urethan U.S.P. (Ethyl Carbamate), Riboflavin U.S.P., Pelargonic Acid, and 2-Ethyl Heptanoic Acid.

Animal Feed Products: Antibiotic Feed Supplements, BHT Products (Antioxidant), Calcium Pantothenate, Choline Chloride, CURBAY B-G®, Special Liquid CURBAY, VACATONE®, Menadione (Vitamin K_3), DL-Methionine, MOREA® Premix, Niacin USP, Riboflavin Products, Special Mixes, U.S.I. Permadry, Vitamin B_{12} Feed Supplements, Vitamin D_3, Vitamin E Products, Vitamin E and BHT Products.

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Division of National Distillers and Chemical Corporation
99 Park Avenue, New York 16, N. Y.

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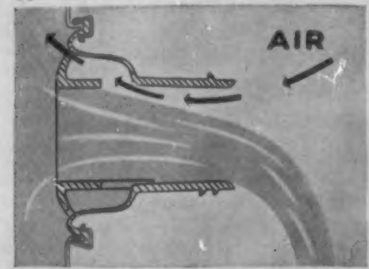

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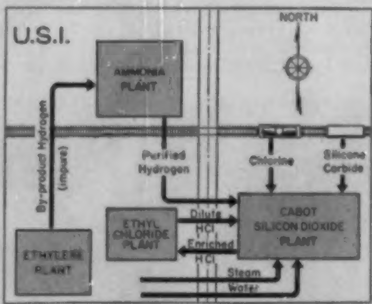

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New pump eliminates contact of moving parts with fluid handled. Intake and outlet consists of one flexible tube passing through pump body and acted upon by kneading action of double rotor. Handles corrosives and abrasives. **No. 1373**

Molybdenum pentachloride — active catalyst for chlorinating aromatics, Friedel-Crafts alkylations and like reactions — can now be obtained in semiworks quantities. Also "plates" molybdenum when reduced by hydrogen. **No. 1374**

New needle-and-glass syringe combination packed in sterile polyethylene bag is now available. Entire unit is designed to be discarded after use. Glass barrel unaffected by solvents during long contact with parenteral fluids. **No. 1375**

All phases of the flexographic printing process are covered in a new, revised, updated edition of an older book. Now on sale, new volume includes sections on copy preparation and halftone printing by flexography. **No. 1376**

New centrifugal filming machine for sterilizing sensitive biological fluids and producing high-potency vaccines by ultraviolet irradiation now in production. Suggested for polio vaccines, blood plasma, liquid foods. **No. 1377**

Fiber glass finishing agent which establishes a better bond between fibers and resins is now available in semiworks quantity. Reported to give better wet and dry strengths to polyester, epoxy, melamine, phenolic laminates. **No. 1378**

For liquid oxygen systems, new thread sealing compound is now available. Is specifically formulated for negligible impact sensitivity, is claimed to have approval of several rocket motor manufacturers. **No. 1379**

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High point in Jubilee ceremony — The Awards Session. Here those who have made unusual contributions of initiative and inspiration to the development of the profession, the Institute, and the science were honored in a ceremony of great dignity.

CELEBRATION in PHILADELPHIA

. . . roundup on A.I.Ch.E.'s anniversary meeting

"It's not really been work—just a lot of fun". . . . "It's taken a real spirit of adventure". . . . "The profession has been my life". . . . "There were so many others who helped". . . . "We're only starting—now a founder society and next in a new Center". . . .

These were the comments of the five men who, on the night of June 23rd, had just been given the first Founders Awards, highest award ever accorded by the A.I.Ch.E. Council.

Standing before a packed Grand Ballroom of Philadelphia's Bellevue Stratford Hotel, president Holbrook explained that the Founders Award was, for the first time in A.I.Ch.E. history, an award without limitations or conditions of any kind. It is to be given to the very best men in the profession—men who have performed outstanding and long service to the profession, the Institute, and the science of chemical engineering.

Turning to recipients T. H. Chilton, J. V. N. Dorr, O. A. Hougen, S. D. Kirkpatrick, and W. K. Lewis, Holbrook said, "when you think of this award, think of a masterpiece . . . not something with any single outstanding point, but a masterpiece overall. . . ." Presentation was by Earl P. Stevenson.

As a prelude to the awardings, a procession filed down the center aisle of the auditorium, consisting of participants, past presidents, and members of Council, led by vice-president Katz.

Three of the forty original charter members, who took part in the organizing of the Institute 50 years ago, are alive and were presented with citations. Frederic Dannerth, responding for the other two—D. W. Horn and Jerome Alexander—who could not be present because of health, spoke with his usual vigor (termed "active septuagenarian"—CEP, May '58) in saying, "you have guided the Institute

Highlight of Awards Session was address by Lee A. DuBridge, noted educator. Said DuBridge: "There is no more searching or difficult problem for a free people than to identify, nurture, and wisely use its own talents."

Celebration in Philadelphia

to its Golden Age. I hope that this night will usher in a period of human understanding for all who succeed us . . ."

A certificate citing fifty-years of continuous membership was presented to further honor Jerome Alexander.

Past officers and directors were awarded honor medallions. Edward R. Weidlein as the second-oldest past president (1927-28) responded for the group, and democratically reminded those present that, "We fully realize that the tremendous growth could not have taken place without the backing of the membership, a group that wanted something finer, something more professional . . ."

The address by Lee A. DuBridge will be reviewed in a later issue.

Gala Golden Jubilee Banquet. Seated are representatives of domestic organizations, and the Department of Defense. Mr. Greenewalt, president of DuPont, is speaking. "If we preserve with jealous care," Mr. Greenewalt concluded, "the liberties, responsibilities, and incentives that have brought our country to so high a place . . . the future . . . cannot fail to be bright . . ."

The Keynote

Earlier that same day, the same auditorium hushed as a voice spoke out the words, ". . . enrich us with those durable satisfactions of life, so that the multiplying years may not find us bankrupt in those things that matter most, the golden currency of faith and hope and love . . ."

This prayer preceded the first official ceremony of the Jubilee. It was spoken by the Reverend Frederick Brown Harris, Chaplain of the United States Senate, and veteran of many historic ceremonial occasions.

This was the occasion of the Keynote Session, presided over by Clifford C. Furnas, and dedicated mainly to the purpose of hearing greetings from President Eisenhower, the Governor of Pennsylvania, the Mayor of Philadelphia, and the University of Pennsylvania, Villanova University, and Drexel Institute.

More than the usual "welcome" was expressed in these messages. Speakers analyzed the role and the contributions of the chemical engineering profession and the Institute. The relationship between these and the national, state and local bodies represented was shown as important and continuing. Clear, throughout, was the close relationship between

President Holbrook (left) congratulates recipients of the Founders Award. Standing (left to right), Warren K. Lewis, MIT, Thomas H. Chilton, DuPont, Sidney D. Kirkpatrick, McGraw-Hill. Seated: John Van Nostrand Dorr, Dorr-Oliver, Olaf A. Hougen, Univ. of Wisconsin.

Dramatic moment at banquet. A previously unnoticed wrapped chandelier was lowered, the wrapping removed, and the thus exposed birthday cake—with 50 candles—lighted to the singing of the familiar verse.

At the banquet, in their finery: (left to right) director C. A. Stokes, Mrs. McConomy, director J. J. Healy, Jr., Mrs. Roy A. Kinckiner, vice - president D. L. Katz, H. F. McConomy, and Mrs. Katz.

Also at the banquet, in gala mood: (left to right) C. H. Thayer, Mrs. Chalmer G. Kirkbride, director John J. McKetta, Mrs. Olsen, W. R. Grimble, Mrs. Clifford L. Rassweiller, J. L. Olsen, and Mrs. Grimble. Couple in foreground unidentified.

the profession, and the people.

The Keynote Address by Monroe E. Spaght, will be reviewed later.

Ceremonial Session

On the stage of the University of Pennsylvania's Irvine Auditorium on Wednesday, assembled fifty delegates of domestic and foreign professional societies, and their hosts. All were wearing academic robes with the variety of colors of the hoods that designate the academic institution and the degree represented by the wearer.

Primary purpose of the Ceremonial Session was the conveyance of greetings from the other societies. These were transferred from the delegates to the president of A.I.Ch.E., Mr. Holbrook, as uniform parchment rolls resembling graduation diplomas. Reason for this was the great variety of the actual documents—which were so impressive that they were later put on display in a protected aisle area of the headquarters hotel.

Jonathan E. Rhoads, provost of the University of Pennsylvania, expressed the honor felt by that body in having so long participated in the affairs of

continued on next page

Ceremonial delegates and hosts preparing for procession. At center is representative of a physics society.

Ceremonial Session. A. Norman Hixson of the host institution, the University of Pennsylvania, is at the lectern. In the forward two rows are the delegates of societies sending greetings.

the profession, and in being selected as host for this Ceremonial occasion.

James Creese, president of Drexel Institute, spoke on education, and his address will be reviewed later.

A general greeting from Foreign Societies was spoken by L. A. Bhatt, president, Indian Institute of Chemical Engineers, who emphasized the viewpoint of the nations abroad toward chemical engineering as a truly American development.

Greetings from Domestic Societies were addressed to President Holbrook —almost in the form of a toast—by Augustus B. Kinzel, president of A.I.M.E.

In responding, president Holbrook traced briefly the pattern of growing interrelationships within the profession, and between groups throughout the world. "This ceremony, attended as it is by delegates from twenty-six societies in twenty foreign countries, symbolizes the close bonds of the chemical engineers of the future . . ." said Holbrook.

Assistant secretary of Defense for Research & Engineering, Paul D. Foote, addressed the assembly, relating the modern role of science and technology to the security and preservation of free social structures.

Keynote Session. Monroe E. Spaght is addressing the assembly on the changing patterns of attitude towards culture. To Mr. Spaght's immediate right is president Holbrook. In background is C. C. Furnas, chairman of Session. Other persons represent the State, the City and local universities.

Golden Jubilee Banquet

High social occasion of the Jubilee was the Banquet. A colorful affair —with the ladies in their finest— was made even more pleasant by an elaborate decor at the triple dais, and a string orchestra playing in the background. Following the usual good natured introductions by president Holbrook, and the toastmastership of Chalmer G. Kirkbride, the audience was addressed by Crawford G. Greenewalt, president of DuPont, on a subject probably closer to the minds of many Jubilee attendees than any other—the relationship between our personal freedom and our ability to make the contributions that may be expected of us, to preserve the freedom of those who will succeed us . . .

(*More on the Jubilee in August*)

Press conference for foreign delegates. In center, publicity chairman Stark directs questioning, while TV newsreel cameramen prepare for interview recordings. Left of Stark is Bhatt of India; right is Wicke of Gemany and von Stein of Austria.

John A. Oriel, past president of the (British) Institution of Chemical Engineers, discusses development of a petrochemical industry.

Soviet delegates S. I. Volfkovitch, Soviet Academy of Sciences, and N. M. Zhavoronkov, Mendeleyeff Institute of Technology (standing).

future meetings

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Financing for the Chemical Industry: Bernard Stott, First National City Bank of New York City, New York, N. Y.
Chemical Engineers in Chemical Industry Management: T. P. Forbath, American Cyanamid Co., 488 Madison Ave., New York, N. Y.
Training on the Job for Industry: John Happel, Dept. of Chem. Eng., N. Y. University, University Heights, New York 53, N. Y.
Alternate Energy Sources: Henry F. Nolting, Standard Oil Co., Whiting, Ind.
Properties of Liquids: S. E. Isakoff, Engineering Research Laboratory, Du Pont, Wilmington, Del.
Preparation of Catalytic Cracking Charge Stocks and Quality Criteria Therefor: Wheaton W. Kraft, Lummus Co., 385 Madison Ave., New York 17, N. Y.
Solar Energy Research: J. A. Duffie, Director of Solar Energy Laboratory, Univ. of Wisconsin, Madison, Wis.
Hydrometallurgy—Chemistry of Solvent Extraction: G. H. Beyer, Dept. Chem. Eng., Univ. Mo., Columbia, Mo.

In addition to the above, the following symposia in the management area are available from J. Happel, Dept. of Chem. Eng., New York Univ., University Heights, New York 53, N. Y.:
Market Research • Financing • Growth of the Chemical Industry • Distribution Between Dividends and Growth in Financing • Stock Market Analysis for Chemical Companies • International Growth • Filling Vacancies in Top Management • Duties of a Good Director • Where Chemical Engineers Go After Graduation • Long Term Planning.

Claimed to be the world's largest single installation for desalting sea water, a $10 million Government-owned plant in Aruba, Netherlands Antilles, has gone into production. Total capacity of the plant, designed and built by Singmaster & Breyer of New York, is 2.7 million gallons a day of distilled water. Bonus from the process is a marketable surplus of electricity. Preliminary cost estimates indicate a production cost of about $1.75 per 1,000 gallons.

Three chemical plants and an asphalt production unit, to a total value of 2.8 million will be engineered and constructed in Europe by Badger-Comprimo N. V., The Hague. Two of the chemical plants will be in England and the third in Germany, while the asphalt production unit is for Esso Belgium.

Under license from Metal & Thermit Corp., New York, Societe des Usines Rhone-Poulenc, Paris, will manufacture, for distribution in Continental Europe, a number of organotin compounds developed by Metal & Thermit. In exchange, M & T will use several Rhone-Poulenc patents in the United States.

Now on stream is a $3.5 million Udex extraction plant complex at the Vickers Petroleum Co. plant at Potwin, Kansas. Production at the new BTX plant is expected to reach over 15 million gallons of petroleum aromatics annually. Feed stock comes from a recently-completed Ultra-former with a daily capacity of 3,500 barrels.

Soviet technology at New Jersey

First-hand view of Soviet Technology, solids-liquids separation, and catalysis are featured at New Jersey One-day meeting

Perhaps the "contest" between the Soviet Union and the Western democracies is no real contest, just as there is no real contest between Harvard University and General Motors, concluded J. P. Nielsen, Chairman of NYU's metallurgical engineering dept., in his first-hand view of Soviet Technology in his luncheon address at the joint **New Jersey and North Jersey Ch.E. Club** One-day technical meeting, May 6 *(John M. West)*. By analogy, Nielsen pointed out that GM has the very specific objective of manufacturing automobiles and making money, while Harvard is primarily concerned with expanding the fields of knowledge. In a sense, the democracies resemble the universities, in that they wish to expand the fields of social justice. This is an important problem for the democracies—and it is hoped, that the best minds are at work towards a solution.

Corporate state

As a clearer indication of what the Western world is up against, Nielsen likened the operation of the USSR to a large corporation; all industries, research, and education are coordinated to achieve the objectives deliberately planned by the party . . . engineers and scientists are delivered by the educational institutions according to the quantitative demands of the industrial and research establishments.

Coordination

A further aspect of the coordination between departments is the close liaison between educational institutions and industrial establishments for the practical experience of students during their five years in college.

All of this presents a challenge to the democracies, in that they do not spell out such specific objectives on an overall basis, with the result that their progress follows a capricious path.

Solids—liquids

Selection of the best method of separating solids from liquids is rarely simple. Several fundamentally different principles, including sedimentation and filtration may be used. Even when the general principle and kinds of forces have been specified, a bewildering array of equipment is available for solids-liquids separations. In outlining a general approach to the separation problem, J. C. Smith, of Cornell Univ., spelled out the types of equipment, some desirable preliminary tests, and some guideposts that help in finding the best method and most suitable type of separating equipment.

This was the first presentation in the symposium on solids-liquids separation. A parallel symposium treated catalysis.

Filtration tests, methods of evaluating filter media, and the apparent inconsistencies in test results were discussed by C. A. Jahreis of T. Shriver & Co. At the same time he reviewed

the problem of selection and sizing of pumping equipment. In defining the increasing complexity of new developments in continuous filtration, A. Dahlstrom of Eimco, included rates of cake formation, cake dewatering, cake washing, solubles removable, and thermal drying. In describing new developments, he covered the theory and development of rate functions, with application to scale-up, specific applications of new equipment, and referred to flocculation with synthetic polyelectrolytes.

In general, there are two different types of centrifuges—those operating on a sedimentation principle and those operating as filters; either can be operated manually or automatically. A number of new designs have been developed and introduced recently (especially within the last ten years). Some of the more interesting new applications in the chemical industries were described by J. T. Costigan of Sharples, in the separation symposium.

The current status of our thinking on the nature of catalysts, and some of the detailed chemistry involved in the more important catalytic reactions were detailed by A. G. Oblad of M. W. Kellogg, as he led off the catalysis symposium. He gave some answers of how catalyst activity, selectivity, and stability enter into the practical use of catalytic chemistry.

The advantages and disadvantages of catalyst types from an engineering aspect were discussed by C. E. Schildknecht of Stevens Tech. despite his purely chemical approach to the subject of catalytic advances in polymerization. Following this, the growth of catalytic processes in petroleum refining was traced by L. P. Evans of Socony.

The versatile catalytic functions of the platinum group metals were outlined by G. Cohn of Engelhard. Besides the classic uses of platinum catalysts, he described other process applications, such as: reduction, dehydrogenation, dehalogenation, and oxidation. Platinum metal catalysts are being developed for the purification of industrial gases and for the elimination of air pollution.

Chemical engineer's day in Toledo

By special proclamation, May 9, was designated as "Chemical Engineer's Day" in Toledo, Ohio in recognition of the fact that the **Toledo Section** *(L. W. Larsen)* was host for

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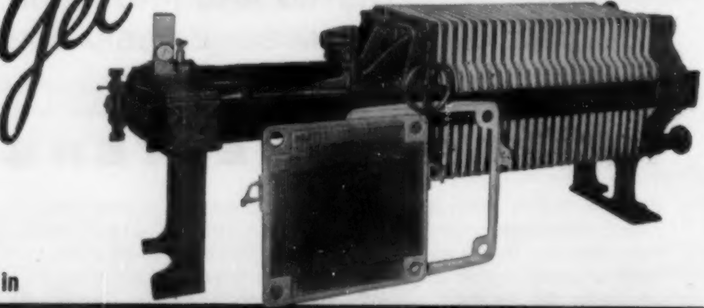

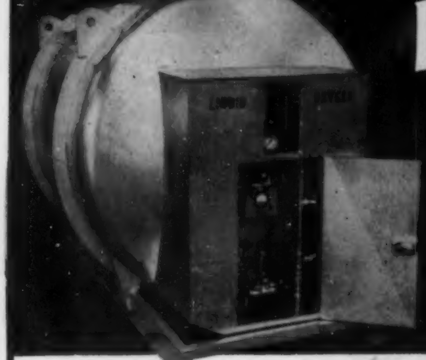

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a joint One-day technical meeting including: **Akron, Central Ohio, Cleveland, Detroit, Ohio Valley, Pittsburgh,** and **Toledo** local sections on that day. Mayor John W. Yager, of Toledo, who was present at the luncheon, presented the proclamation to L. W. Larsen, past Chairman of the **Toledo Section.** The meeting featured a series of eight papers on pneumatic, electronic, and chemical control systems. There were 319 at the meeting, of which 174 were members.

May 9, 1958 was designated "Chemical Engineers' Day" in Toledo by special proclamation of Mayor John W. Yager, right, seen here presenting the Proclamation to Toledo section Chairman L. W. Larsen.

Industry will face more government intervention and big power, that has been placed in the hands of the labor unions, was the warning sounded in the keynote address by R. B. Semple, President of Wyandotte Chem. Co. Although the chemical industry will continue to grow during the coming decades, competition of the larger established companies will make it increasingly difficult for the small-scale operator to start a chemical manufacturing business of his own. Even the established companies will find more and more competition, not only within the industry, but from large concerns who are adding the manufacture of chemicals to their customary activities; which are often entirely unrelated. To cut down on labor, and to improve quality, Mr. Semple continued, that the established chemical companies will also require more automation.

Peninsular Florida is new local section

The continuing growth of the Institute is reflected in Council's acceptance of the **Peninsular Florida Section** *(Charles E. Huckaba)* after almost

two years of successful operation as a Club. The timing of the Council action enabled the annual technical meeting of the Club to be the first meeting of the new local section. A diversified technical program for the meeting was largely built around Florida chemical industries and some of their problems. Topics ranged from gum naval stores, one of Florida's oldest industries, to zirconium, one of the newest.

How the raw materials for zirconium, found in Florida sands, are processed to the pure metal at the new plant of the Columbia-Southern Corp. at Pensacola, was described by Ed Sherry of Columbia-Southern; and the Olustee process, pioneered in Florida for the production of rosin and turpentine from pine gum, was discussed by Hugh Summers of U.S. Dept. of Agriculture.

In consideration of the prevention of air pollution, A. J. Teller of Univ. of Florida analyzed the application of chemical engineering design to air pollution problems, and L. E. Bostwick of Intn'l Minerals & Chem. Corp., outlined how one of the phosphate processing companies has worked out a practical solution to the problems of fluorine recovery from stack gases.

Some of the radiation facilities being developed at the Univ. of Florida from a 2.8-million dollar grant, were described by J. M. Duncan; and the potential usefulness of these facilities to the industries of the state was emphasized. Using as an example one of his "home grown" water supply controls costing about $25, in place of a $2500 installation recommended by an instrument company, H. M. Burt, of Lehigh Portland Cement Co., described how application of chemical engineering ingenuity can sometimes save a company thousands of dollars.

Southern Students Conclave

Fourteen local student chapters were represented at the **Southern Regional A. I. Ch.E. Conference** *(C. A. Basore)*, March 26-28, held at Alabama Polytech. The Conference featured talks on rockets, rocket propellants, petrochemicals, the synthetic fiber industry, and electronic computers, given by engineers from local chemical engineering firms. Also featured were students' papers.

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local sections

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Also meeting

Endorsing the local campaign for safety in the handling of explosives by would-be rocketeers, the **Southern Nevada** section, joined with other local chemical and engineering societies in their area in urging drug stores, science teachers, and others having access to "reactive chemicals" to refrain from supplying these materials to juvenile experimenters. As a potent, thought-provoking punch line, the campaign published, "These kids can become scientists only if they retain their eyesight and keep their fingers on their hands. . . ."

The growing problem of providing pure water for industrial uses was described to **South Texas (A.I.Ch.E.)** *(C. L. Fitzgerald)* and many other engineering societies of the area at a joint meeting in Houston in November by E. P. Partridge, Director of the Hall Laboratories. He stressed three points: the distinction between withdrawal and consumption of water, the facts concerning the need for ultra-pure water, and the fact that industrial waste should be treated at the point of maximum concentration. By way of elaboration, he stated that withdrawal and consumption is sometimes confused. Industry as a whole, consumes only about 2% of the water it uses, and returns the other 98% to streams, lakes, or original sources. In discussing the use of extremely high purity water, Partridge pointed out the accelerated corrosion rates at the high temperatures used in generating steam at pressures above the critical, or in ranges from 4500 to 5000 lb. per sq. in. Corrosion of steel tubes in pure water takes place at high temperatures because iron passes through iron oxide surfaces and reacts with the water. In addition to this, an intergranular type of destruction occurs due to hydrogen attack. Instead of talking of parts per million as contaminants, engineers and water experts now talk in terms of parts per billion for large central stations developing this high pressure steam. For boilers of this type, chemical conditioning cannot be used. Makeup is less than 1%, and even this is treated and returned. In discussing waste water, he commented that the best way to treat it so that it would be fit for consumption, would be to treat the water at the point where pollution is greatest. In this way, the volume to be handled is the least, and the percentage correction is greatest.

A. I. Ch. E. candidates

The following is a list of candidates for the designated grades of membership in A.I.Ch.E. recommended for election by the Committee on Admissions. These names are listed in accordance with Article III, Section 8 of the Constitution of A.I.Ch.E.

Objections to the election of any of these candidates from Members and Associate Members will receive careful consideration if received before August 15, 1958, at the office of the Secretary, A.I.Ch.E., 25 West 45th Street, New York 36, N. Y.

MEMBER

Bailie, George E., *Chicago Heights, Ill.*
Barnhart, James H., *Corpus Christi, Tex.*
Bradley, John G, *Richland, Wash.*
Busch, Joseph Sherman, *Pittsburgh, Pa.*
Chao, George Tsei-Yu, *Canoga Park, Calif.*
Colletta, Victor Joseph, *Weehawken, N. J.*
Crow, John H., *Dallas, Tex.*
De Keyser, Henry D., *Corpus Christi, Tex.*
Eason, Walter E., Jr., *Baltimore, Md.*
Evans, Douglass F., *Espanola, N. M.*
Fleming, Graham, *Brooklyn, N. Y.*
Grossman, Seymour L., *Philadelphia, Pa.*
Holman, John C., *Chile, S. A.*
Kam, Samuel Sheung-Woo, *Singapore, Malaya*
Knight, Graham B., *Boston, Mass.*
Landry, Wesley J., *Port Neches, Tex.*
Lister, Bruce A., *Terrytown, N. Y.*
Misner, William G., *Wilmington, Del.*
Patterson, David J., *Tuscola, Ill.*
Rasmussen, E. Hart, *Belleville, N. J.*
Reehl, Robert F., *Arsenal, Ark.*
Roe, Julian H., *Long Beach, Calif.*
Roy, Tuhin K., *New Orleans, La.*
Salamone, Jerome J., *Belleville, N. J.*
Schutze, E. J., *Dallas, Tex.*
Spoor, Ivan H., Jr., *Corpus Christi, Tex.*
Taylor, Herman, Jr., *Pt. Arthur, Tex.*
Thomas, David G., *Oak Ridge, Tenn.*
Walker, Rodger, *Alberta, Canada*
Wall, Keith D., *Fullerton, Calif.*
Weisberg, Harold E., *Adelphi, Md.*
Wierman, Leslie B., *Midland, Mich.*

ASSOCIATE

Bailey, John A., *La Mirada, Calif.*
Ball, Hubert T., Jr., *Texas City, Tex.*
Barfoot, Robert O., *Chester, Pa.*
Bethea, Robert Morrison, *Ames, Iowa*
Canaley, Peter S., *Rochester, N. Y.*
Carroll, Charles F., *Allison Park, Pa.*
Chionsini, A. E., *Pt. Neches, Tex.*
Cook, Paul A. C., *Library, Pa.*
Cooley, Carl R., *Richland, Wash.*
Eliassen, John D., *Johnson City, Tenn.*
Ellingsen, Walter R., *Wilmington, Del.*
Estrin, Joseph, *Wilmington, Del.*
Fozo, Geza, *Philadelphia, Pa.*
Garcia, Rafael Jorge, *Braithwaite, La.*
Gardner, G. C., *Monroeville, Pa.*
Graham, Harry D., *Woodbury, N. J.*
Groening, F. E., *Wilmington, Del.*
Herold, George O., *Philadelphia, Pa.*
Hexter, Richard M., *Los Angeles, Calif.*
Klein, Barry F., *Santa Monica, Calif.*
Kratky, John M., Jr., *St. Louis, Mo.*
Lane, Arthur Glen, *Park Forest, Ill.*
Laurence, Robert L., *East Greenwich, R. I.*
Liu, Hun-Giam D., *Wellsville, N. Y.*
Londner, Michael I., *Brooklyn, N. Y.*
Lucas, Michael J., *Pekin, Ill.*
Lyster, William N., *Baytown, Tex.*
Mason, Joseph C., Jr., *Claymont, Del.*
Mayorga, Gilbert, *Houston, Tex.*
McAfee, Jack T., *Pt. Arthur, Tex.*
McComb, John B., *Portland, Ore.*
McLean, Robert H., *Claymont, Del.*
Mieskiewicz, Henry J., *Rochester, N. Y.*
Morrison, Gary C., *Royston, B.C., Canada*
Nicoll, Harold I., *Houston, Tex.*
O'Leary, Joseph T., Jr., *Elizabeth, N. J.*
Otis, James L., *Midland, Mich.*
Pelczarski, Eugene A., *Cheswick, Pa.*
Pulley, Dan P., *Richmond, Va.*
Quiann, Robert A., *Rochester, N. Y.*
Richardson, Meck L., *Bishop, Tex.*
Roy, Kenneth B., Jr., *Pensacola, Fla.*
Rueping, Calvin F., *Groves, Tex.*
Rychlowski, Jerome Edward, *Morristown, N. J.*
Schoen, Herbert M., *Stamford, Conn.*
Scott, Charles D., *Oak Ridge, Tenn.*

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Charleston Chapter Honors Doolittle

A. K. Doolittle, senior scientist at Union Carbide's Research Center in South Charleston, W. Va., was recently honored by the Charleston chapter, A. I. Ch. E., for "his devotion and contribution to the chemical engineering profession and the local section." On hand at the presentation of an engraved silver tray were (left to right): John K. Harvey, assistant superintendent at Carbide's South Charleston plant, Doolittle, R. V. Green, technical specialist, duPont, and Edward J. Cannon, staff assistant at Carbide's Institute plant.

Doolittle is the holder of 22 patents, the author of numerous technical articles, and the author of a book, "The Technology of Solvents and Plasticizers." He was one of the original founders of the A. I. Ch. E. Charleston section, and was national director on the A. I. Ch. E. council from 1951 to 1954. He was vice-president of A. I. Ch. E. in 1955, but was forced to decline nomination for the presidency in 1956 because of ill health.

Sydney B. Self, for many years chemical and drug specialist for the Wall Street Journal, joins Goldman, Sachs & Co. as a member of its Securities Research Dept. Self will continue to specialize in the chemical and drug fields.

Armour Research Foundation of Illinois Institute of Technology has appointed two technical consultants to its chemistry and chemical engineering department. They are **Elbert C. Lathrop,** formerly of the Northern Regional Laboratories of the U. S. Department of Agriculture in Peoria, Ill., and **Aristid V. Grosse,** president of the Research Institute of Temple University. Grosse was the first to isolate element 91, protoactinium.

New Manager of industrial research for M. W. Kellogg is **Raymond E. Vener** (top), formerly worked at Catalytic Construction where he was engaged in process design, research, sales and technical publications. Also at Kellogg, **E. F. Liebrecht** has been elected president of Kellogg International Corp. Liebrecht, who will continue as a vice-president of M. W. Kellogg, will be headquartered in London.

Robert W. Cairns, director of research for Hercules Powder, has been elected vice-president and president-elect of the Industrial Research Institute. Cairns is a former Deputy Assistant Secretary of Defense, and is currently serving on the Defense Science Board.

Eli Goodman, senior chemical en-

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gineer for Nuclear Science & Engineering Corp., Pittsburgh, Pa., has been awarded the first annual Meritorious Achievement Award of the Pittsburgh Chapter of the American Nuclear Society.

Rensselaer Polytechnic Institute has awarded an honorary Doctor of Science degree to **Monroe E. Spaght**, executive vice-president of Shell Oil Co. Spaght was principal speaker at the Keynote Session during the recent Golden Jubilee Meeting of A.I.Ch.E. in Philadelphia.

Thomas M. Ware has been elected president of International Minerals & Chemical Corp. He succeeds his father, **Louis Ware**, who was elected chairman of the board and chief executive officer.

An honorary doctor of science degree has been awarded by Phillips University, Enid, Oklahoma, to **Herman R. Thies**, general manager of Goodyear Tire & Rubber Company's Chemical Division.

S. C. Streep, formerly of Davison Chemical Division of W. R. Grace, is now vice-president and general manager of International Metalloids, Inc., of Toa Alta, Puerto Rico. The firm, a joint venture of Grace and Pechiney (France), will make ultra-high purity metallic silicon for the electronics industry. Streep is a former secretary of the Maryland Section, A. I. Ch. E., and was secretary of the 1957 National Meeting of A. I. Ch. E. in Baltimore.

Charles L. Ruby (top) and **William C. Randall** have been promoted to group supervisors in process planning at the Richmond Laboratory of California Research Corp. Ruby will study refinery process correlations and crude oil surveys and analyses, while Randall will concentrate on product blending in refineries and planning and evaluating refinery processes.

B. F. Goodrich Chemical has named **Quandt M. Adams** as senior

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CLASSIFIED SECTION

Address Replies to Box Number care of:

CHEMICAL ENGINEERING PROGRESS
25 West 45th Street
New York 36, New York

SITUATIONS OPEN

EXCEPTIONAL HIGH SCHOOL SCIENCE TEACHING OPPORTUNITY

New Science Department, community intensely interested in developing strong science department because of mining and chemical processing industries. Salary if B.A. + 24 and 5 years' teaching experience, $6100: if M.A., $6500. Write Superintendent, Trona Unified School District, Trona, California, for complete information.

SITUATIONS WANTED

A.I.Ch.E. Members

EXECUTIVE CHEMICAL-MECHANICAL ENGINEER—Twenty-three years' experience from shop to Vice-President. Chemical plants, textiles, petrochemicals, heavy plate and code vessels. Reg. P.E. Age 43. Desire challenging position with growing, aggressive firm. Box 5-7.

CHEMICAL ENGINEER—M.S. Princeton and M.I.T. Broad experience in organic chemical development: pilot plant, economic evaluation of products and projects, market research, technical-management liaison, research administration. Fine chemical, pharmaceutical, and petroleum residual background. Box 6-7.

CHEMICAL ENGINEER—Age 36, B.Ch.E., P.E. Nine years' engineering experience including two years as production supervisor. Experienced in chemical equipment design, instrumentation, and project management. Proven ability to direct other engineers and to arrange and coordinate construction contracts. Interested in responsible plant or project engineering position. Box 7-7.

CHEMICAL ENGINEER—Age 28, B.S.Ch.E. Six years' excellent experience in production supervision, process design, economic evaluations, and long range planning. Not afraid of hard work nor challenging problems. Good organizer, aggressive, have imagination and initiative. Desire responsible position with chemical or engineering firm within 150 miles of New York City. Box 8-7.

CHEMICAL ENGINEER—B.Sc.Ch.E. Sixteen years' experience in research and development, process and project engineering for petroleum refineries and petrochemical plants. Now on consultant assignment in Germany. Foreign languages perfect—German, some Dutch and Russian. Seek representation in Europe for engineering or manufacturing firm. Box 9-7.

SENIOR CHEMICAL ENGINEER—M.I.T. 1942, P.E. Wide experience in process design and development, pilot plant supervision, economic studies and project appraisal, facilities planning and construction, plant start-up. Minimum salary, $12,000. Box 10-7.

PRODUCTION MANAGEMENT ENGINEERING—Age 40, M.Ch.E. Fifteen years' experience in chemical food processing and aerosol packaging plants. Plant manager, process engineer, process evaluation and development, production supervision, seeking responsible position in production management. Present salary $11,000. Box 11-7.

CHEMICAL ENGINEER — Production plant management, supervision and pilot plant development experience. Record of substantial cost reductions and profit improvements. Self starter with a shirt sleeve approach when necessary for leadership. Publications. Family. Fifteen years' substantial experience in the petroleum and petro-chemical industry. Desire connection with a reasonable opportunity for advancement in either production or production supporting activity. Box 12-7.

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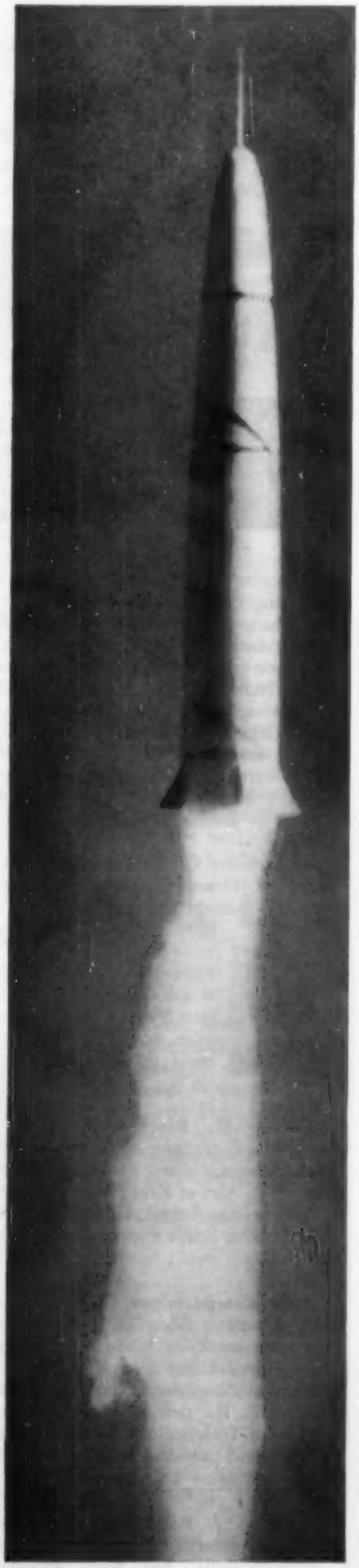

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PROCESS-PROJECT ENGINEER—M.S.Ch.E. Ten years of this experience with major chemical companies; active all phases engineering, from economic analysis to start-up trouble shooting; desire solid chemical engineering position; prefer best-paying, most active location. Box13-7.

SALES, CHEMICAL ENGINEER—Two years' sales experience plus background in production and quality control with major company. Seeking career opportunity with progressive company. Philadelphia area preferred. Age 29. Family. Box 14-7.

SUPERVISORY CHEMICAL ENGINEER—Twenty years' varied experience performing and directing projects in petrochemicals, organics, waste disposal, process development evaluation and control, and market investigations. Proven record. Desire responsible challenging position. Location open. Age 44. Box 15-7.

VERSATILE ENGINEER — M.Chem Eng. minoring in sanitary engineering. P.E. Four years' process development experience in inorganic chemicals and abrasives. One year statistical design of experiments. Finance and statistics at night school. Desire position in economic evaluation or mkt. research. Age 29. Married. Box 16-7.

CHEMICAL ENGINEER—B.S. Thirteen years' experience project engineering, process design, plastic and chemical plants, synthetic liquid fuels development. Desire challenging, responsible position with medium or small company. Age 38. Present salary $10,000. Box 17-7.

GRADUATE CHEMICAL & MECHANICAL ENGINEER—Fifteen years' experience planning, directing, development, applied research, process engineering, design of commercial plants. Management experience, fluent French, German, some Spanish, Swedish. Free to relocate. Box 18-7.

SENIOR CHEMICAL ENGINEER — M.Ch.E. Honor societies, patents, publications. Experienced in all phases of process design and development, pilot plant supervision, economic studies and project appraisal, budget planning, facilities planning and plant start-up. Age 38. Box 19-7.

CHEMICAL ENGINEER—Age 28, married, veteran. Bs.Ch.E. 1956. Two years experience in Technical Service and Development work. Desire progressive position in pilot plant, development or industrial chemical production. Will relocate. Box 20-7.

CHEMICAL ENGINEER—B.Ch.E. Age 28. Experienced in process development, process engineering, and production supervision. Seek challenging position with responsibility, demonstrated abilities and proven record. Type of man that you need in a key position in your organization. Box 21-7.

CHEMICAL ENGINEER—B.S., M.S. 1954. Five years' experience in process-trouble-shooting, process improvement and cost reduction. Some design experience. Seeking responsible position along same lines or economic evaluation. Fluent Spanish. Box 22-7.

CHEMICAL ENGINEER — B.S. 1951. Five years' experience at major oil refrinery in operations and economic analysis. Desire to relocate in midwest in responsible position involving economic studies and/or technical applications of electronic computers. Married, age 29, two children. Box 23-7.

CHEMICAL ENGINEER—B.Ch.E., 1951, age 31, veteran. About five years' experience, four years of which are in responsible position in pilot plant process development. Formerly GS-11 at $7035 in government. Design, development, or production. Box 24-7.

PRODUCTION MANAGEMENT ENGINEERING—M.E. Licensed. Thirty years diversified experience in heavy chemicals, design, construction and operation. Have been chief engineer two major chemical companies and plant manager. Seeking responsible position in production management. Box 25-7.

CHEMICAL ENGINEER—B. Sc. Ch.E. Four years process design and project engineering in heavy chemicals. Heat transfer equipment, fluidised systems, scrubbing, dust collection, ventilation. Desire position in production or process development. Age 33, family Box 26-7.

SENIOR ENGINEER—Seven years' experience petroleum processing, design, operations analysis, coordination, planning. Experienced digital computers, operations research techniques (statistics, linear programming, etc.) Member Tau Beta Pi, Sigma Tau. Desire supervisory or management advisory position. Willing locate foreign or domestic. Fluent Spanish. Box 27-7.

CLASSIFIED SECTION RATES

Advertisements in the Classified Section are payable in advance at 24c a word, with a minimum of four lines accepted. Box number counts as two words. Advertisements average about six words a line. Members of the American Institute of Chemical Engineers in good standing are allowed one six-line Situation Wanted insertion (about 36 words) free of charge a year. Members may enter more than one insertion at half rates. Prospective employers and employees in using the Classified Section agree that all communications will be acknowledged; the service is made available on that condition. Answers to advertisements should be addressed to the box number, Classified Section, Chemical Engineering Progress, 25 West 45th Street, New York 36, N. Y. Telephone COlumbus 5-7330. Advertisements for this section should be in the editorial offices the 10th of the month preceding publication.

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people in management & technology

from page 133

technical man at its glacial acrylic acid plant in Calvert City, Ky. Adams worked on the development of the acrylic acid process at the company's development center in Avon Lake, Ohio.

Garnet T. Page has been appointed general secretary of the Engineering Institute of Canada. Page was formerly general manager and secretary of the Chemical Institute of Canada. He joined the Engineering Institute in 1957 as assistant general secretary.

Humble Oil & Refining announces promotions of **B. B. Ashby** and **J. C. Dickson** to senior chemical engineers in the Technical Division of its Baytown, Texas, refinery, and of **R. A. Speed** to senior research chemical engineer in research and development at Baytown Research Center.

At Esso Research Laboratories in Baton Rouge, La., **B. V. Molstedt** has been appointed engineering associate. He is replaced by **J. W. Carr, Jr.** as head of the Engineering and Operating Group. **M. M. Lambert** has taken up an assignment in long-range planning. His former position as assistant section head in chemicals will be filled by **C. W. Seelbach.**

At Atlantic Research Corp., Alexandria, Va., **Presson S. Shane,** (left) has been named director of the new Solid Propellant Division, and **Robert O. Webster** director of the new Mechanical Engineering Division. Shane was formerly with McGean Chemical Co., and Webster was head of Atlantic Research's Missile Engineering Group.

Among Chemstrand Corp. employees who will attend intensive executive development programs in July at three different universities are: **A. A. Nellis,** Acrilan Plant technical superintendent; **M. R. Dalton,** manager, District Sales Office, Charlotte, N. C.; and **C. R. Stehman,** head of the research process section at Chemstrand's Research and Development Center in Decatur, Alabama.

Esso Standard Oil announces appointment of **Donald M. Cox** (left) as general manager of the company's supply department. Cox succeeds **George T. Piercy,** who becomes assistant manager of the coordination and petroleum economics department of Standard Oil (N. J.).

George P. Baumann has been named an engineering associate at Esso Research and Engineering, Linden, N. J. Also at Esso Research, **John F. Ryan** has been made a section head in the firm's chemicals research division.

Karl Kammermeyer, head of the Department of Chemical Engineering, State University of Iowa, participated in the recent European Congress of Chemical Engineering in Frankfort, Germany. He delivered a paper on "Modern Training of Chemical Engineers", and presided at the session on Heat and Mass Transfer.

Clifford J. Rassweiler, vice-president for research and development of Johns-Manville, has been awarded

the honorary degree of Doctor of Science by the Polytechnic Institute of Brooklyn. Rassweiler joined Johns-Manville in 1941, after 17 years with the duPont research organization.

R. P. Dinsmore, vice president in charge of research and development for Goodyear Tire & Rubber Co. has received a special citation from Indiana Technical College, Fort Wayne, Ind., for "outstanding contributions to industrial development."

Theos J. Thompson, associate professor of nuclear engineering and director of the new nuclear reactor at MIT, has been named full professor. Also at MIT, **Melville Clark, Jr.** has been promoted to associate professor of nuclear engineering.

New president of the American Institute of Industrial Engineers is **George H. Gustat,** director of the industrial engineering division at the Kodak Park Works, Eastman Kodak Co.

Callery Chemical Co. has appointed **Lewis A. Barry** as operations manager of its research and Development Division at Callery, Pa. Barry came to Callery in 1952 from Kennametal, Inc., Latrobe, Pa.

Robert E. Latimer has joined Air Products, Inc., Allentown, Pa., as assistant to the vice-president of engineering.

Chemical technical service activities at Davison Chemical have been consolidated under **F. Emerson Ivey, Jr.,** as manager. Ivey came to Davison in 1948 from Gulf Oil Co.

John A. Hufnagel has been appointed manager of the New York office of Catalytic Construction Co.

A Sloan Fellowship for advanced work at the School of Industrial Management at M.I.T. has been awarded to **Carl R. Gloskey,** research manager at Metal & Thermit's laboratories, Rahway, N.J.

Andre Charles Deprez, formerly a research engineer with duPont, has joined Scientific Design Company as a process engineer.

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Classified.... EQUIPMENT SECTION

people in marketing

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Alsop Engineering has appointed **Arvid Willen** to its sales engineering staff. Willen will operate directly from the firm's main office in Milldale, Conn., and will serve the territory covering Connecticut, New York above Westchester County, Western Massachusetts, and part of Vermont.

At Celanese Corp. of America, **Kenneth A. Scott** and **Oliver Axtell** have been transferred to the Technical and Economic Evaluation Department.

New advertising and sales promotion manager at Beckman Systems Division is **Ray St. Onge**. Since joining Beckman in 1953, St. Onge has been a field engineer in New York and Detroit,

Donald F. Baumler has been named district sales manager of the new Downingtown Iron Works sales office in Buffalo, N. Y. Baumler was formerly manager of fabrication sales for Farrar & Trefts, Inc., and its successor, Yuba Consolidated Industries.

Matthew S. McCauley, director of business research for Monsanto's Organic Chemicals Division in St. Louis, has been appointed director of marketing research for the division. McCauley has been associated with Monsanto since 1929.

Columbia-Southern Chemical Corp. has appointed **Leroy C. Nelson** as assistant district sales manager for their New York office. Nelson joined Columbia-Southern in 1938

A.I.Ch.E. Candidates

from page 131

Slaughter, Robert H., *Houston, Tex.*
Sutton, Richard H., *Tuscola, Ill.*
Szachnitowski, Stanley A., *Chicago, Ill.*

Thompson, W. Robert, *Havertown, Pa.*
Trautner, Robert John, *Torrance, Calif.*
Valesano, Dominic J., *Whiting, Ind.*
Webber, Stanley D., *Murray Hill, N. J.*
Weinberg, Erwin, *New York, N. Y.*
Weiss, Irving, *Brooklyn, N. Y.*
Wendt, Carl J., Jr., *Los Angeles, Calif.*
Yanagi, Takashi, *Los Angeles, Calif.*

AFFILIATE

Conde M., Julio Castro, *Guatemala City, C. A.*
Dross, Allen E., *Dugway Proving Ground, Utah*
Karvelas, Louis, *Houston, Tex.*
Lampton, Albert W., *Richland, Wash.*
Powell, A. Stuart, Jr., *New York, N. Y.*
Saylak, Donald, *Wilmington, Del.*
Trost, Peter A., Jr., *Texas City, Tex.*

INDEX OF ADVERTISERS

C.E.P. Advertising offices

New York 36—Lansing T. Dupree, Adv. Mgr.; John M. Gaede, Asst. Adv. Mgr.; Paul A. Jolcuvar, Dist. Mgr.; Donald J. Stroop, Dist. Mgr.; 25 W. 45th St. COlumbus 5-7330.

Chicago 4—Martin J. Crowley, Jr., Dist. Mgr.; Robert Kliesch, Dist. Mgr.; 53 West Jackson Blvd., Room 504, HArrison 7-3760.

Cleveland 15—Eugene B. Pritchard, Dist. Mgr., 1836 Euclid Ave., SUperior 1-3315.

Pasadena 1, Calif.—Richard P. McKey, Dist. Mgr., 465 East Union St., RYan 1-0685.

Dallas 18—Richard E. Hoierman, Dist. Mgr., 9006 Capri Drive, Davis 7-3630.

Birmingham 9, Ala.—Fred W. Smith, Dist. Mgr., 1201 Forest View Lane, Vesthaven, TRemont 1-5762.

Did You Know . . .

. . . that the first chemical engineer in the atomic energy field was Marie Curie . . . that Iceland expects to supply most of the power for her developing industry from geothermal wells . . . that David Wesson, the discoverer of the vacuum-deodorizing of cottonseed oil, was a founder of the A.I.Che.E. . . . that chemical engineering has recovered more than 50 per cent of the value of coal used for coking . . . that the ancient Egyptians used filter presses . . . that the A.I.Ch.E. was the first engineering society to accredit college curricula . . . ?

news and notes of A.I.Ch.E.

Citation of the A.I.Ch.E. was made by the U. S. Department of Commerce for our participation in the International Trade Fair Program. The Institute has helped the Department's fairs by supplying literature on chemical engineering, & according to the citation we have "contributed significantly to the advancement of world understanding of peace and prosperity under the American system of free enterprise."

Local Sections—N. R. Maleady, past president of the Atlanta Section, notes the effect a membership directory has on a local section. Last year L. Hutzler of Atlanta issued the first membership directory of the section, giving position, company, & home address. In preparing for the directory, the committee canvassed the entire section mailing list, asking members to fill out the directory questionnaire & to send in their dues. This had the effect of increasing dues collections & of weeding out those who had no interest in the section.

Membership Dues—Irv Leibson has asked that it be brought to the attention of all the members that last year Council changed the annual dues for Affiliated Members under 35 to $14. This brings them in line with the Associate Member dues for the same age bracket.

Also on membership activities—the Northern Division of the Membership Committee is well ahead of the Southern Division: 201 to 153 at the end of May. . . The application blanks from college seniors are coming in as heavily this year as last, which is heartening proof that the chemical engineering story is being appreciated by the newly entering members of the profession. The Student Chapter Counselors are behind this interest 100 per cent & it is through their enthusiasm & example that a student is encouraged to join. Spearheading the student phase of the membership drive is Bob Schecter.

How to Strengthen the Local Section—Other organizations are concerned with local sections, we find from the recent Newsletter of the Association Institute, which gives six ways to strengthen a local chapter suggested by the Advertising Federation of America. They are repeated here for the aid and comfort they may give to Local Section chairmen and program men. . . . One, work with colleges and universities. (Our Local Sections do this.) Two, make the club paper a real news medium. (Some of our sections do have very informative, chatty bulletins.) Three, sponsor high school essay contests. (National office knows of no Local Section that does this but would be pleased to hear about it if any do.) Four, organize a speaker's committee. (We collect from Local Sections every year a list of outstanding speakers, which is made available to all Local Sections and program men.) Five, send out more and better news releases. (This very solid and worthwhile activity for many of our Local Sections is covered by a bulletin published by the national office. If you haven't one, write for it.) The sixth suggestion is to promote Advertising Week, for which Engineers' Week and Chemical Progress Week are useful substitutes.

Committee work—Occasionally we are asked how one volunteers for a committee of the A.I.Ch.E. One of the best ways is to indicate interest in the work to the committee chairman, whose name will be found in the lists published in the Directory of A.I.Ch.E. (Anyone who hasn't a directory may obtain one from headquarters.) Then there is another way; twice a year the Secretary's office writes to all Local Section Chairmen giving a list of the Institute committees & a description of the duties of each committee & of individual members. Recommendations are requested for submission to the committee chairmen & new committees are made up annually from these selections plus holdovers & those who have indicated their interest in the work. Committee work is a rich & rewarding experience, one of the values to be obtained from a professional society such as the A.I.Ch.E.

F.J.V.A.